EXHIBIT 12

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF NORTH CAROLINA
SOUTHERN DIVISION
No. 7:23-CV-00897

IN RE:
CAMP LEJEUNE WATER LITIGATION

This Document Relates to:
ALL CASES

EXPERT VIDEO-RECORDED DEPOSITION OF
LEONARD KONIKOW, PHD

Tuesday, February 25, 2025
9:38 AM EST

Reported by: Denise Dobner Vickery, CRR, RMR
Job No. MDLG7172979

Tuesday, February 25, 2025
9:38 AM EST

Video-Recorded Expert Deposition of LEONARD KONIKOW, PHD, held in the conference room of:

WASHINGTON DULLES MARRIOTT SUITES
13101 Worldgate Drive
Herndon, VA 20170

Pursuant to notice, before Denise Dobner Vickery, Certified Realtime Reporter, Registered Merit Reporter, and Notary Public in and for the Commonwealth of Virginia.

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PRESENT BY ZOOM:

Deanna Havai
Dennis Reich
Tim Thompson
Jeffrey Davis
Morris Maslia
Devin Botlon
Bill Williams
Alex Spiliotopoulos

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P R O C E E D I N G S

- - -

THE VIDEOGRAPHER: Good morning. We are now on the record.

My name is Gene Aronov. I'm videographer for Golkow Veritext division. Today's date is February 25th and the time is 9:38 AM.

This video deposition is being held at the Washington Dulles Marriott Suites, 13101 Worldgate Drive, Herndon, Virginia in the matter of Camp Lejeune Water Litigation versus United States of America for the Eastern District of North Carolina. The deponent is Leonard Konikow.

Would counsel please introduce themselves for the record.

MR. DEAN: Good morning. Kevin Dean on behalf of the Plaintiffs Leadership Group and the witness.

MS. BAUGHMAN: Laura Baughman on behalf of Plaintiffs Leadership Group and the witness.

MR. ANWAR: Haroon Anwar Department of Justice for the United States.
MR. ANTONUCCI: Giovanni Antonucci for the United States.
MS. SILVERSTEIN: Kailey Silverstein for the United States.
THE VIDEOGRAPHER: The remote participants will be noted on the stenographic record.
The court reporter is Denise Vickery will now swear in the witness.
- - -
LEONARD KONIKOW, PHD
called for examination, and, after having been duly sworn, was examined and testified as follows:
- - -
EXAMINATION
- - -
BY MR. ANWAR:
Q. Good morning, Dr. Konikow.
A. Good morning.
Q. My name is Haroon Anwar. I am a

lawyer for the Department of Justice here to take your deposition today in the Camp Lejeune Justice Act Litigation.

A. Okay.

Q. Do you understand that?

A. Yes.

Q. Okay. Have you ever sat for a deposition before?

A. One time.

Q. Okay. Well, you may recall that experience, but I just wanted to go over some ground rules to help the deposition today go as smoothly as possible.

A. Good.

Q. First, you're -- you're under the oath to tell the truth as if you were in an actual court of law.

A. Okay.

Q. Do you understand that?

A. Yes, I do.

Q. And is there any reason, sitting here today, that you would be unable to testify truthfully?

A. No.

Q. Okay. We have a court reporter sitting right next to you taking down everything, typing down everything for the record.
A. (Nods head).
Q. To make life easier for her, if we could avoid speaking over each other --
A. Okay.
Q. -- it will -- it will make for a cleaner record and a happier court reporter. She can't get everything down when we're speaking over each other.
A. (Nods head).
Q. Fair enough?
A. Fair enough.
Q. Okay. And sort of corollary to that is, to help with that, if you could pause or after I ask my question, maybe pause for a second and then respond.
Fair enough?
A. Okay.
Q. Okay. If I ask a bad question or a question that you need clarification on -- and it's very possible I would do that today -- could you let me know, please?

A. I will.
Q. Okay. If you don't let me know, I will assume that you understood the question. Fair?
A. Yes.
Q. Okay. Now, we'll be going for a few hours today. If at any point you need a break, just let me know. This isn't intended to be punishment. The only -- the only stipulation I would put on that is if there's a pending question, I'd ask that you answer that question, and then we can take a break.
Fair enough?
A. Yes.
Q. Okay. And I'll try to take a break every hour or so anyway.
A. Good. Okay.
Q. Now, I want to start by asking you what you did to prepare for today's deposition.
A. Well, a number of things. Over the past several weeks, I reviewed all of the reports from ATSDR for the Tarawa Terrace model and Hadnot Point/Holcomb Boulevard.
Last week I flew down to South

Carolina to meet with these lawyers, a few other lawyers, and Morris Maslia were there for basically two days of meetings. And then yesterday I met with Kevin and Laura just to discuss general questions, such as the things you just pointed out to me and had to respond.
Q. Sure.
A. Yeah.
Q. For the meeting last week, the two-day meeting in South Carolina with the lawyers and Mr. Maslia, was there anyone else present besides lawyers and Mr. Maslia?
A. Besides the lawyer -- there were several lawyers and myself and that's -- that's all I recall being there.
Q. Okay. No -- no non-lawyers other than Mr. Maslia?
A. No what?
Q. No non-lawyers other than Mr. Maslia?
A. I don't believe so.
Q. Did you review any documents during that meeting?
A. What do you mean by "reveal"?

Q. Did you review documents?
A. Oh, review?
Q. Correct.
A. During the meeting?
Q. During the meeting last -- last week, the two-day meeting with the lawyers and Mr. Maslia.
A. We may have looked things up for to check some facts, but I don't think there was anything that was a review of a document necessarily. I mean, we looked at some documents to answer some questions, but, you know, in terms of reviewing, if you mean like a technical review, that was not done.
Q. Okay.
A. But for specific points, there may have been discussions.
Q. Understood.
Did you -- I guess understanding I'm not asking about technical review sort of from a scientific perspective. Understanding that you are a scientist.
Did the documents that you reviewed with the lawyers and Mr. Maslia, did they help

refresh kind of your recollection about points that you were discussing?

A. It did. Occasionally, you know, something would come up, and we would look at one of the reports that ASDR -- ATSDR published.

Q. Okay. Do you recall what documents you reviewed during the two-day meeting last week?

A. I believe we looked at the chapter of the Tarawa Terrace that described the summary and findings and probably the groundwater flow model and maybe even the transport model.

Q. That was for Tarawa Terrace?

A. Tarawa Terrace and similar, you know, I don't remember exactly which ones we looked at, but I suspect we did the same types of documents for Hadnot Point when we talked about that.

Q. Understood.

Do you recall during last week's two-day meeting reviewing any other documents?

A. I do not.

Q. How about during yesterday's meeting? Was that -- did that meeting take place with Kevin and Laura?

A. It was in this room yesterday.
Q. Okay. And with the attorneys -- with your attorneys here present today; correct?
A. The two attorneys that are here today, yes.
Q. Understood.
Did you review any documents during yesterday's meeting?
A. I don't -- I don't recall that we did. I mean, maybe I don't remember, but I don't remember us reviewing any documents yesterday.
Q. Understood.
About how long -- how long did the meeting yesterday last?
A. It was probably about six hours, not counting lunchtime.
Q. All right. Did you do anything else besides the two separate meetings that we've discussed to prepare for your deposition today?
A. To prepare for the deposition? No, not that I can think of.
Q. Okay. But -- and I should say, besides the two meetings last week and this week with your -- the lawyers and Mr. Maslia and then

you had testified, I believe, that you had went through and reviewed the ATSDR modeling reports; correct?

A. Yes.

Q. Okay. Besides that, did you do anything else to prepare for your deposition today?

A. No.

Q. Okay.

(Document marked for identification as Konikow Exhibit 1.)

BY MR. ANWAR:

Q. I am handing you what is being marked as Konikow Exhibit 1.

Have you seen this document before?

A. (Reviews document.)

Yes, this looks familiar.

Q. Okay. I'll represent to you it's the notice for deposition and the subpoena scheduling your deposition --

A. Yeah.

Q. -- today.

A. Okay.

Q. I wanted to direct your attention to

Attachment A. There are three document requests there.

The first one is for e-mails, letters, correspondence, text messages, conversations, chats, voicemails, and communications pertaining to Camp Lejeune prior to your retention as an expert in this litigation.

Do you see that there?

A. Yes.

Q. And we received a document production from your counsel last night.

A. Yeah.

Q. Did that document production contain all of the responsive documents or communications you have in response to request number 1?

A. Well --

MR. DEAN: Object to form, except, you know, we've served an objection.

MR. ANWAR: Understood.

MR. DEAN: So subject to that.

THE WITNESS: I had responded I believe, several weeks ago with e-mails and then yesterday with other documents

that I realized were covered up. But I wasn't intentionally not, you know, I wasn't intentionally not sending those forward.

I just -- I was focused on the e-mails, letters, correspondence part of this, and I had some files from my service on the expert panels in 2005 and 2009. And until Sunday, this past Sunday, it just didn't pop into my head that those were covered by this. It was just an oversight on my part.

BY MR. ANWAR:

Q. Understandable and, you know, I'm not suggesting you did anything --

A. Yeah.

Q. -- anything wrong.

I'm just trying to confirm --

A. Yeah.

Q. -- whether -- what was produced in response to this subpoena.

And so request number 2 is essentially the same thing. E-mails, letters, correspondence, communications with any of --

anyone that has filed a claim in this litigation.

And then request number 3 asks for bills, invoices, and other documents reflecting compensation paid.

In response to these three requests, did you give your lawyers everything that you have?

A. At this time, I would say I gave everything that I have, yes.

Q. Okay. Is there anything that you can think of related to Camp Lejeune prior to your retention as an expert in -- in this current litigation, communications, documents that you have in your possession currently?

A. That I have not turned over?

Q. Correct.

A. No. As far as I know, I've turned over everything.

MR. ANWAR: Okay. Thank you. You can set that aside.

(Document marked for identification as Konikow Exhibit 2.)

BY MR. ANWAR:

Q. I'm going to hand you now what is

being marked as Exhibit 2. There you go.
Dr. Konikow, is this a true and correct copy of the rebuttal report -- expert report that you submitted in this case?
A. It appears to be.
Q. Okay. Is there anything in your rebuttal report -- well, let me back up for a second.
This rebuttal report on page 33 is dated January 13; correct?
A. Yes.
Q. That's when you signed the report; correct?
A. And sent it probably to Kevin, yes.
Q. Sure.
And is that your electronic signature there on page 33?
A. It is.
Q. Okay. Since submitting the report and giving it to the lawyers on January 13, 2025, is there anything in your rebuttal report that you now believe is incorrect?
A. Yes.
Q. What -- what is that?

A. On page 10 -- let me look at my copy. Page 11 line 10 it says "equivalent to a fraction or 0.001," the word or should be "of" o-f. So just a typographical error.
Q. Understood.
And this is the sentence starting with "OCC is equivalent to TOC?
A. Yes.
Q. "And 0.1% is equivalent to a fraction of .001"?
A. Yes.
Q. Is there anything else, as you sit here today, that you believe is incorrect in your report?
A. No.
Q. Is there anything in your rebuttal report that needs to be updated, as you sit here today?
A. Not that I'm aware of, no.
Q. Is there any portion of your rebuttal report that you believe is incomplete?
A. Not -- no, not that I can think of.
Q. And does your rebuttal report contain all of the opinions that you intend to

offer in this case?

MR. DEAN: Object to the form. Subject to anything that you might ask him in the deposition not covered by the notice -- I mean, the report.

THE WITNESS: I may have other opinions. I'm not, you know, I mean, from my review of those two expert reports, these are the comments that I felt were significant criticisms that I thought were worth making.

If something else comes up, I probably have another opinion. So I don't think I could say that these are the only opinions I would give. You ask me a question, I'll give you my opinion.

BY MR. ANWAR:

Q. Sure.

So aside for any conversation we have in the deposition today, does this report contain all of the opinions that you intend to offer in the litigation?

A. Well, you, again, if I, you know, if I'm asked questions about something other than

this, I would offer an opinion on it.

So I'm really not sure about the question what -- what it is encompassing but...

Q. Sure. I understand that.

I guess with the caveat that we may discuss things both contained in your report and not directly referenced in your report in today's deposition.

Putting that aside, is there anything -- are there any other opinions that you're currently aware of that you intend to offer in this case that aren't reflected in your report?

A. Not that I can think of.

Q. Okay.

(Document marked for identification as Konikow Exhibit 3.)

BY MR. ANWAR:

Q. I'm going to hand you what I'm marking as Konikow Exhibit 3.

A. (Reviews document.)

Q. Dr. Konikow, is this a complete list of the materials you considered in forming the opinions in your rebuttal report?

A. I believe so.

Q. Okay.
A. I'll look. There's a number of documents listed at the end, and I'm not sure exactly what those refer to.
Q. Okay. This document, Exhibit 3, that I handed you, it's titled "January 2025 Rebuttal Expert Report of Leonard Konikow, PhD, National Academy of Engineering" and then underneath it says "Materials Considered List" and it's dated January 21, 2025; is that right?
A. Yes.
Q. Okay. And as you sit here currently, you're not aware of anything else that should have been included on this Materials Considered List that's not included?
A. Not that I'm aware of.
Q. Okay. Did you review the rebuttal reports of or the rebuttal report of Morris Maslia?
A. I believe I did.
Q. Okay.
A. I don't recall it specifically, though.
Q. But you may have?

A. Yes.
Q. Did you review a rebuttal report from David Sabatini?
A. I believe I saw it. I saw something from Sabatini.
Q. Okay. Did you review the rebuttal report from Norman Jones and Jeffrey Davis?
A. Yes.
Q. And did you review the rebuttal report from Kyle Longley?
A. I -- I don't -- I -- yeah, I'm not sure which report that was. Is that the one related to the history or something?
Q. Yeah. Correct.
A. I think it was sent to me and I just glanced at the first page or so, and I did not review that whole report.
Q. Understood.
Do you have any opinions about the -- any of those rebuttal reports that aren't reflected in your -- in your own report?
A. Well, my report really focused on Alex and Remy's report, and I don't think there's any comments in here on the other rebuttal

reports.

Q. Okay. And as you sit here today, you don't intend to offer comments on the other rebuttal reports outside of any discussion we may have today in the deposition?

A. Correct.

Q. Okay. Did you listen to or review the transcripts for the deposition of Mustafa Aral?

A. I did. Yes, I looked at it. I read it.

Q. Okay. Did you either listen to or review the transcripts for the depositions of Norman Jones and Jeffrey Davis?

A. I believe I did.

Q. Do you have any opinions about anything that was said in those depositions that aren't reflected in your -- your own expert report, your rebuttal report?

MR. DEAN: Object to the form. Subject to whatever you may ask in this deposition or I do as a follow-up.

BY MR. ANWAR:

Q. You can answer.

A. Well, there's nothing in my expert report about the testimony or deposition of Jones and Davis. I read it. I may have some opinions on it, but it was nothing that belonged in my rebuttal report.

Q. Okay. Outside of any discussion we have today in the deposition, do you intend to offer any opinions related to anything that was said in -- well, strike that.

Outside of any discussion we have today during our -- the deposition, as you sit here, do you intend to offer any opinions based on the depositions of Mustafa Aral, Norman Jones, and Jeffrey Davis?

A. That's not my intent, but if I'm asked, I would try to answer the question to the best of my ability.

Q. Understood. Thank you.

Do you know Norman Jones?

A. I've met him once or twice. I do not know him personally very well, just, you know, other than an introduction at a professional meeting or something like that.

Q. Where did you meet him?

A. I've attended so many professional meetings in the last 40 years, I really -- I don't remember. It may have been a National Ground Water Association meeting. It may have been a Geological Society of America meeting. I go to, you know, many of these and occasionally our paths him across. It was probably one or two sessions where we were both speakers in a symposium, and I'm sure I shook hands with him, said hello, but nothing more than that.

Q. Understood.

Aside from crossing paths in professional settings once or twice, it sounds like you haven't -- you don't know Norman Jones otherwise; correct?

A. When I was -- well, basically the answer is no, I don't know him, but I believe I had another interaction with him in the last five years related to a man- -- I was editor-in-chief of Groundwater Journal for four years. And during that time, I believe he had submitted one manuscript not related to Camp Lejeune, and so we had some correspondence related to that, but had nothing to do with Camp Lejeune.

Q. Do you have any recollection what that manuscript was about?
A. I believe it was about an area called Spring Valley in Nevada or an adjacent area in Utah. I know it focused on the City of Las Vegas, trying to develop well fields in an area maybe a couple hundred miles north of Las Vegas, but in a valley in Nevada that extended into Utah. And they wanted to develop water supplies on the Nevada side, pump a lot of wells, and it would have had impacts on the Utah side. So he was -- the manuscript focused on that situation.
Q. Well, did that manuscript involve groundwater or transport modeling? Do you recall?
A. My recollection it probably, but I can't -- I don't have total recollection. It probably involved groundwater flow modeling.
Q. Okay.
A. Probably did not involve transport modeling.
Q. Understood.
In that instance, it sounds like it may have involved groundwater modeling for the purposes of developing supply wells outside of Las

Vegas; is that right?
A. It was related to that, but I think his focus was on assessing the impacts of that pumpage on water supplies on the aquifers in Utah.
Q. Okay. Aside from that manuscript, have you worked with Norman Jones on any other projects?
A. No.
Q. Do you know Mustafa Aral?
A. I've met him.
Q. Okay. In what context have you met Dr. Aral?
A. Serving on expert peer review panels for ATSDR in 2005 and 2009. I believe he was at both of those meetings, to the best of my recollection, and I met him there and we may have talked. You know, I don't remember. I believe he gave some presentations to the expert panel committees, but I don't remember the details.
I don't recall ever meeting him outside of those two meetings.
Q. Have you ever worked with Dr. Aral before outside of those two meetings, the ATSDR meetings?

A. No, not to recollection.
Q. Do you know Jeffrey Davis?
A. I believe I met him somewhere along the line, but I can't recall the occasion. I saw he said he was involved with the board of directors of National Ground Water Association, and while I was an editor for their journal, we probably attended meetings together at their annual meetings. And we probably talked there, but I have no direct recollection of that.
Q. Okay. So outside of those professional meetings, you don't know Jeffrey Davis; is that right?
A. That's correct.
Q. Have you ever -- and you haven't worked with Mr. Davis before?
A. Not that I could recall.
Q. Do you -- do you know David Sabatini?
A. No.
Q. Never met?
A. Well, again, I may have met. If he was at the 2005 or 2009 meetings, I probably met him, but I do not recall meeting him.

Q. Understood.

Earlier you mentioned reviewing all of the ATSDR reports.

It sounds like the modeling reports for Tarawa Terrace as well as the model -- modeling reports related to Hadnot Point and Holcomb Boulevard; is that right?

A. That's correct.

Q. Did you do anything further than review the reports?

A. I'm not sure what that would -- could include, but no, I mean, I read the reports. I didn't do anything else with them.

Q. Did you attempt to reconstruct ATSDR's models for Tarawa Terrace or Hadnot Point and Holcomb Boulevard?

A. I did not.

Q. Did you attempt to reevaluate the input parameters or assumptions upon which the Tarawa Terrace model or the Hadnot Point/Holcomb Boulevard model were based?

A. Well, I mean, part of my review was looking at their discussions of the parameter values, and I certainly, you know, considered them

and looked at, you know, what, you know, that they looked reasonable, you know.

Q. Outside of what's contained in your report and what we -- we discuss today, do you have any -- any opinions about ATSDR's parameter of values or input values?

A. Can you repeat that, please?

Q. I guess -- well, let's -- we'll come back to that. Let's that was maybe a bad question.

I'm going to hand the court reporter to hand you what is being marked as Konikow Exhibit 4.

(Document marked for identification as Konikow Exhibit 4.)

THE WITNESS: (Reviews document.)

BY MR. ANWAR:

Q. The first page of Exhibit 4 states "Attachment A" which was attached to your expert report, and Attachment A is a copy of your curriculum vitae; correct?

A. Yes.

Q. Okay. Is this a true and accurate

copy of your curriculum vitae?

A. Yes.

Q. Is it current?

A. Pretty current. I think I updated it a couple months ago.

Q. To the best of your knowledge, as you sit here today, is there anything that you need to update on this curriculum vitae?

A. No. Again, this -- this includes -- it's not a complete detailed list of everything I've ever done professionally --

Q. Okay.

A. -- but it's, you know, what I could get in two pages.

Q. Okay. How did you decide what to include on your curriculum vitae versus what not to include in terms of, you know, everything that you've done professionally?

A. Well, I included the points that I think people would expect to see in a curriculum vitae, my education, so on, and highlights of publications and professional side activities. A few awards that I received that I thought were of particularly high recognition, but I did not

include every award I've ever received or every publication I've ever had published.

Q. Understood.

As part of Exhibit 4, there's also an Attachment B, which is Attachment B to your -- your rebuttal report, and it's titled "Publications During Past 10 Years."

Is that right?

A. Yes.

Q. Is this a complete list of your publications during the past 10 years?

A. To the best of my knowledge, it is.

Q. I wanted to ask you a few questions about items on your CV.

I wanted to start by asking you whether you would describe yourself as a hydrogeologist; is that right?

A. That's how I usually describe myself, yeah.

Q. Is there any other title that you describe yourself with?

A. Occasionally, you know, my official job position with -- during my career with the U.S. Geological Survey, most of the time I was

called, in fact probably all the time, I was called a research hydrologist.

Q. Okay. Do you consider yourself an expert in groundwater transport and water distribution modeling?

A. I am not an expert in water distribution modeling, but I do consider myself an expert in groundwater flow and transport processes in modeling.

Q. Is there any other subject area that you consider yourself an expert in?

A. I think hydrogeology, groundwater flow, and transport processes probably encompasses all of it.

Q. Okay. Now, you spent the bulk of your career at the U.S. Geological Survey; right?

A. Yes, sir.

Q. And then it looks like from your CV your most recent role was editor-in-chief of Groundwater Journal from 2020 to 2023; is that right?

A. Yeah, four years.

Q. Four years from 2020 to 2023?

A. Yeah, inclusive. All those years,

you know, from January 1st of 2020 to December 31st of 2023.

Q. Understood.

Are you currently retired?

A. Yes. Well, except for this. (Laugh).

Q. Except for the serving as a Camp Lejeune expert; correct?

A. Yes.

Q. Okay. Under -- I wanted to talk to you a little bit about some of your selected professional activity on your CV.

It looks like that throughout your career you've served on committees or panels for the National Research Council; is that right?

A. That's correct.

Q. Okay. From -- and I'm looking at your CV.

From 1981 to 1982, you served on an NRC panel on groundwater contamination; is that right?

A. That is correct.

Q. What did you do in this role?

A. Well, to the best of my

recollection, again, that one is, you know, more than 40 years ago, but as a panel member, we discussed the -- the problem of groundwater contamination, which was just in the late '70s becoming much more widely recognized as an important problem.

And the National Research Council had asked me to serve on this panel, and I thought it was a worthwhile activity. We would typically have discussions among the whole committee, as well as listen to presentations from experts that they brought in. I had no role in selecting who they brought in but, you know, and then we would have discussions.

And then somewhere after, you know, the first or second meeting, we started working on writing a report and, to the best of my recollection, a book came out from that activity.

Q. What book came out of that activity?

A. I believe it was just a National Research Council report published by National Academy Press. Something in the title about groundwater contamination. There may have been some other words there, but I don't recall. I

haven't looked at that report in a while.
Q. Okay. Did you take part in writing any part -- any portion of that book?
A. Most likely, yeah.
Q. So either on the book itself or in the chapters, you likely would be listed as an author?
A. I don't know that they listed authors. I think they listed it in terms of who was members of the committee that wrote the report.
Q. Understood.
Do you know how you were selected to serve on that NRC committee on groundwater contamination?
A. No, I do not.
Q. You mentioned, I guess, other experts served on that committee; correct?
A. Yeah. Yes.
Q. Would it be fair to say you were selected to serve on that committee because of your expertise as a hydrogeologist?
A. I presume so.
Q. Do you know how other experts were

selected to serve on that committee?
A. I do not.
Q. Do you remember any of the experts that you -- you served on that committee with?
A. On that committee, I do not remember. I did not look at that report probably in the last year or two years or five years. I just -- I don't remember who else was on that committee. If I looked at the report, it would refresh my memory.
Q. Understood.
Now, looking further on your CV, it looks like from 1987 to 1989 you served on an NRC Committee on Ground-Water Modeling Assessment; is that right?
A. From '87 to '89, yeah. Committee on Ground-Water Modeling Assessment, yes.
Q. What was the committee or what is the Committee on Ground-Water Modeling Assessment?
A. Again, this is done at a time when groundwater modeling was becoming much more widespread and -- and, you know, particularly in the public there wasn't a widespread appreciation among the public or probably politicians and

others, senior level government officials, about what groundwater models could do, how reliable they were and so on. And so this -- this committee was, I believe, was charged to review the state of the art of groundwater modeling.

It's not shown here, but like a subtitle of this committee, or at least of the book that was produced, was something to the effect of groundwater models in a regulatory and environmental framework or assessment, something like that. There was, you know, some additional subtitle that is not listed here. I was trying to keep everything on one line here.

Q. Understood.

What do you -- what did you do in this role on the -- the NRC Panel on Ground-Water Modeling Assessment?

A. We discussed the philosophy of modeling. We discussed the mathematical basis underlying the model. We discussed parameter estimation for the models, how reliable the results are, you know, things on that order, yeah.

Q. Do you know how it came to be that you were selected to be on that committee?

A. No, I do not.
Q. Did you apply to be on that committee?
A. No. I usually don't volunteer for things. (Laugh).
Q. Understood.
It sounds like you were selected to serve on that committee then?
A. Somebody asked me, I don't remember who, and I thought it was a worthwhile activity at the time and so I said sure.
Q. Okay. Do you recall any of the members of -- the other members that served on the Groundwater Modeling Assessment Committee?
A. I do.
Q. Who? Who were they?
A. Frank Schwartz was the chairman of the committee. He is a professor at Ohio State University. You know, I've known him off and on for many years. Jim Mercer was on that committee. Jim was one of the founders of a company called GeoTrans. I was more or less personal friends with Jim Mercer. He -- his company -- he used to work for the USGS. Formed his own company around

1980. That company was later bought by Tetra Tech, a larger consulting company.

I believe Charlie Andrews from Papadopulos & Associates was on this committee. I've known Charlie off and on, you know, over the years, at least since this time.

Just off the top of my head I can't think. I know there were other people on the committee, but I can't recall who.

Q. Sure.

Now, you mentioned some of the work you did on that Committee about Ground-Water Modeling Assessment.

Do you recall sort of more specifically the nature of that work? Were you -- were you evaluating sites? Were you -- or were you discussing sort of modeling as a -- as a science of itself?

A. I would say both. I think the report focused mostly on the state of the art of modeling. I do recall there were two or three case histories, site-specific studies that were included in the book of examples to illustrate examples of the application of models to real

world complex problems.

Q. Do you recall what any of those sites -- three sites were?

A. I think one of them was a contaminated site in Ohio. Maybe Dyncam, D-y-n. I'm not positive, but that just sort of just popped in my mind.

The other one or two examples I just -- I can't recall at the moment but, you know, if I looked at the book, I would see it but, you know.

Q. Do you recall how groundwater modeling was involved for that site in Ohio?

A. Since it was a contamination problem, I assume there was a groundwater flow model and a related groundwater transport model, a solute transport model.

Q. Do you recall whether you were -- what the purpose of the model was for that Ohio site?

A. I do not.

Q. Do you recall whether it was sort of forward-looking or forecasting or whether it was backwards looking and hindcasting?

A. I don't recall.
Q. Okay. Do you recall what the models for the other two sites were used for?
A. I do not recall.
Q. Okay. Fair enough.
And then on your CV, from 1989 to 1997, it looks like you served on an NRC Committee on Waste Isolation Pilot Plant?
A. Yes.
Q. Could you tell me about that?
A. Sure. The Department of Energy had proposed a site near Carlsbad, New Mexico in thick bedded salt deposits for the disposal of radioactive waste, particularly plutonium waste related to weapons production and, you know, typically these were not high-level wastes in the sense of fuel rods from power plants, which would generate a lot of heat, even in a waste form.
These wastes although in a sense were high level -- they were very toxic -- they were not generating heat. It was basically plutonium garbage waste products.
Q. Understood.
A. Yeah.

Q. And was there a component on that committee -- committee that involved groundwater flow or transport modeling?

A. Yes, that was one of the big concerns, you know, in assessing the safety of the site, the big concern, could anything escape from the site and what's the likely pathway. And it was deemed that, you know, one of the likely pathways, particularly if the site operated to completion in the future and was sealed and closed, the most likely risk would come from water breaching the repository area and then leaking upwards into an overlying permeable aquifer.

And then what would happen to that liquid waste in that aquifer. How fast would it move through the aquifer? How would it spread? What kind of risk did it pose to future humans living downgradient of that?

So, you know, one of the focus of the committee was to assess the Department of Energy's safety assessment and so we were, you know, we looked very critically at everything they did in terms of trying to demonstrate safety.

This was -- and, again, the Waste

Isolation Pilot Plant, to my recollection, it was originally proposed as a pilot plant, which implies that this would be somewhat experimental and, you know, not quite a full operational.

But at some point they changed the name to the WIPP site, just the initials, and it was pretty clear this was going to be an operation. It wasn't an experiment. It was -- it was planned to be an operational waste -- radioactive waste disposal site for what they call transuranic wastes.

Q. Understood.

And it sounds like you were using groundwater modeling, and you may have mentioned transport modeling, but in this context, you were using it for sort of management or planning purposes, for purposes of?

A. Safety I'd say the overriding purpose. There was groundwater flow modeling involved. There was solute transport modeling involved and the overall framework for that and, again, this was just one aspect of many for this committee.

Q. Sure.

A. The groundwater was just one aspect. There were many things and many other experts involved from other disciplines, but the groundwater flow and transport was really based on a safety assessment. And they were expected to demonstrate safety of the site for 10,000 years into the future.

Q. Understood.

On this Waste Isolation Pilot Plant Committee, was there -- did you do any modeling work that you would describe as hindcasting or historical reconstruction?

A. No.

Q. On any of the three NRC committees or panels that you served on, the ones that we've just discussed, have you -- did you do any work model -- modeling work attempting to estimate exposure concentrations for purposes of -- excuse me -- let me -- strike that. Let me -- let me ask that again.

On any of these three NRC committees that we've just discussed, did you do any modeling work that was aimed at aiming -- aimed at estimating contaminant concentrations to be used

for making exposure determinations on individuals?
A. Yes.
Q. Which one?
A. The WIPP site. The WIPP committee. I didn't personally do those, but one of the things that was done by DOE and evaluated by our committee was potential doses to future humans, farmers, living somewhere downgradient from the site that might be exposed. You know, they might have a well, and what if they or their cows drank water from an aquifer after contaminants passed by.
So -- so the answer is yes, that kind of, the dose and the exposure and the consequences had been considered and assessed, but I was not personally involved in any of those calculations, estimations, or assessments.
Q. Okay. And that was looking into the future; correct?
A. It was looking into, I guess we could say, a hypothetical future.
Q. Got you.
And I apologize if I asked you this.
What was your role specifically on

that committee, the WIPP committee?

A. Well, I mean, everyone on the committee had, in a sense, an equal role to contribute towards the goals of the committee and assess presentations made to the committee by DOE and their contractors related to the site. So we were, you know, free and open to question anything on any topic if we had questions about it.

But, you know, I focused on groundwater flow and transport modeling, but I also looked at their human intrusion scenarios and the risk assessments that they made and, you know, basically anything related to the WIPP site, particularly anything that would have a geological or hydrological connection was a primary interest, but I looked at other things also.

Q. Sure.

Were you selected to serve on the WIPP committee -- the WIPP site committee?

A. I must have been.

Q. Okay. In other words, did you volunteer to join that committee, or did someone ask you to join that committee?

A. Someone asked.

Q. Okay.
A. Yeah.
Q. Do you recall any of the other members of that committee, the Waste Isolation Pilot Plant, which we've been referring to as WIPP?
A. Yeah. When I started on it, there was a professor from Stanford named Konrad Krauskopf, I think it is, who is a geochemist. He was the chairman of the committee when I first came on.
John Bredehoeft, a hydrogeologist also worked with the USGS, at least I think at the early part of that time. He retired somewhere around 1990 or so from the Survey. He was on the committee when I first entered, but he had stepped off by the time, you know, before I ended my participation.
A geochemist geologist named Rod Ewing was on the committee. An engineer named Chris Whipple was on the committee. You know, I'd have to take another look.
Oh, John Garrick, who was an expert in risk assessment was on the committee. There

were, you know, five or six other people on the committee that I can't recall their names at the moment.

Q. Fair enough.

You mentioned undertaking a review of DOE's waste disposal plan on that committee; right?

A. Of the Waste Isolation Pilot Plant, yes.

Q. Oh, I'm sorry. Of the Waste Isolation Pilot Plant?

A. Yes, that was the focus of the committee.

Q. How thorough was that review?

MR. DEAN: Object to the form.

THE WITNESS: Well, you know, I think it was a pretty detailed, in-depth review. You know, I would say always questioning what was presented to the committee, looking to delve a little deeper but, you know, the committee did not, you know, reproduce or test or look at every detail of what was presented to us.

It just didn't have the time to do that, but we had, you know, 10 to 12 experts in topics ranging from nuclear physics to materials science, risk assessment, probabilistic analyses, hydrogeology, and so on, and so each person tended to ask some pretty thoughtful questions about areas within their expertise.

I think there was one expert -- I can't remember his name -- on trains, railroads because it had been proposed that the radioactive waste would be transported by rail to the site.

So they got a committee member who was an expert on safety of railroad transportation, and so after a short while they decided they were not going to transport it by rail. So, you know, that was -- but that's an example of the type of expertise that was on the committee.

BY MR. ANWAR:

Q. Understood. Thank you.

Now, these were all NRC committees;

correct?

A. That was the National Research Council. Sometimes NRC is confused with the Nuclear Regulatory Commission --

Q. Okay.

A. -- which is also called the NRC.

Q. (Laugh).

A. But no, this was all National Research Council, which, as best as I understand it, is an arm of the National Academy of Sciences.

Q. Okay. And you anticipated my question.

I was going to ask you: What is the National Research Council?

A. Okay. I'm not sure exactly, but my impression is it is somehow under the realm of the National Academy of Sciences.

Q. Do you have any understanding about the national research's -- National Research Council's reputation?

A. Well, you know, I think their reports are generally well-respected. It probably varies from report to report, and that probably varies from who the particular experts are on the

particular committee were. But if -- if, you know, you want a general report, I think the reports are considered -- for what they do, they're considered to be, you know, reasonable, reliable and, you know, frequently cited.

Q. Generally speaking, would you agree that the NRC is considered a reputable and a prestigious organization?

MR. DEAN: Object to the form of the question.

THE WITNESS: I, you know, I would say it depends on the particular committee but, you know, in general, I think their -- their reports or the books they produce are, you know, considered to be well thought out and reproduced, you know.

You know, there's always particular issues that many people might disagree with but, you know, a broad perspective, yes, they are respected.

BY MR. ANWAR:

Q. Okay. And you mentioned that the National Research Council is part of the

national -- or an arm of the National Academy of Sciences; correct?

A. Yes. I don't understand perfectly what the relation is, but all I know is they somehow fall under the National Academy of Sciences.

Q. What is the National Academy of Science?

A. Basically, there are three organizations under that umbrella. One is the National Academy of Sciences, one is the National Academy of Engineering, and one is the National Academy of Medicine and some other word, which I can't remember.

So there's like three subspecialty areas and three actually they're considered separate institutes or academies that fall under the national -- it's called the National Academies of Science, Engineering, and Medicine Sciences, something like that.

So it, you know, encompasses those three areas and it's a -- my understanding is a nongovernmental organization. Although a lot of their funding comes from government agencies, but

I think -- and I may not have this completely accurate, but my impression is they're independent, standalone. They don't fall under any federal agency.

Q. The National Academy of Science, isn't it made up of scholars elected by their peers?

MR. DEAN: Object to the form of the question.

BY MR. ANWAR:

Q. You can answer.

A. In terms of members, they are elected by existing members is my understanding.

Q. Is being elected as a member to the National Academy of Science generally considered to be an honor?

MR. DEAN: Object to the form of the question.

THE WITNESS: I think so, yes.

BY MR. ANWAR:

Q. And what is your understanding of the National Academy of Science's reputation?

A. My impression is that it has a good

reputation. You know, I personally am -- I was elected to membership in the National Academy of Engineering in 2015, and I considered that a high honor.

Q. I was going to ask. I was going to -- you've been anticipating my question.

A. Sorry.

Q. I've heard membership in the National Academy of Science to be considered one of the highest honors a scientist can receive a U.S. scientist.

It sounds like you agree with that?

A. Basically, yeah. Yes. Yeah.

Q. Now, on page 1 of your CV, under Honors and Awards, you have there in bullet points -- in bullet point sort of the last item bolded among all of the items, "Elected to National Academy of Engineering (2015)" --

A. Yes.

Q. -- correct?

A. Correct.

Q. Okay. What -- what is the National Academy of Engineering?

A. It's one of the three divisions of

the National Academy. It's really the National Academies.

Q. And why did you list it in bold under a section of your CV entitled "Honors and Awards"?

A. I wanted to make sure that it was noticed. (Laugh).

Q. Sure.

A. I consider it an honor. All the other things listed are honors, but I felt that this was probably, among all of those, the highest honor that I had.

Q. Okay. And you list NAE next to the PhD in your name; correct?

A. Yeah. Yes. That indicates I'm a member of the National Academy of Engineering.

Q. And reflecting the fact that you consider it to be one of the highest honors that you've received; correct?

A. Correct.

Q. Okay. Now, I wanted to talk to you a little bit more about sort of the scope of your expertise.

Earlier we discussed that you would

consider yourself a hydrogeologist with expertise in groundwater flow modeling and solute, I think, transport modeling; correct?

A. Yes.

Q. Okay. And if I understood you correctly, there were -- there were no other areas that you consider yourself an expert in; correct?

A. Yeah, I mean, I have some skills in other areas and certainly understandings, but that what you just said is, you know, where I consider my main skills and interests.

Q. Okay. And so this is perhaps a bit obvious, so forgive me, but you're not an epidemiologist; correct?

A. Correct.

Q. You're not a toxicologist?

A. Correct.

Q. The findings of epidemiology, those aren't within your area of expertise; correct?

A. Correct.

Q. And that includes the epidemiologic studies or epidemiological studies performed related to Camp Lejeune; correct?

A. Correct.

Q. You're not an expert on whether a contaminant can cause a disease; correct?
A. I'm not an expert on that, no.
Q. And you're not an expert on the amount of exposure to a contaminant that can cause a disease; correct?
A. That's correct.
Q. Okay. Your report sort of in passing or it references MC -- MCL in a few places.
What is your understanding of an MCL?
A. My understanding is that it stands for maximum contaminant level, and I believe it's a level set by the U.S. Environmental Protection Agency, and it reflects their consideration that any level higher than the MCL creates an undue risk to anyone drinking water with concentrations exceeding that. So it's a level that should not be exceeded in any public water supply.
Q. Understood.
Have you ever been involved in setting an MCL?
A. No.

Q. Okay. You're not aware of the methodology that the EPA uses to establish an MCL, are you?
A. No.
Q. Okay. And you're not aware of how MCLs are set related to health risks; correct?
A. No, I'm not.
Q. You're not aware; correct?
A. Correct, not aware.
Q. Okay. Are you aware of whether an exposure above an MCL presents a health risk?
A. My general impression is that it's -- the MCL is set to distinguish between what is reasonably safe and what poses a health risk. So anything above it, I would assume, reflects some undue risk.
Q. What is that based on? I guess what is your -- that assumption based on?
A. It's based on my understanding of why an MCL would be set for particular chemicals by the EPA.
Q. Okay. But you haven't ever been involved in setting an MCL yourself and you're not aware of the methodology they use; correct?

A. Correct.
Q. Okay. Are you aware that for certain chemicals MCLs are set as close to zero as technically feasible?
A. No, I'm not aware.
Q. Okay. Now, your -- your rebuttal report indicates that you're being paid $400 an hour for your opinion for your work in this case; correct?
A. That's as of January 1st. In 2024 I was charging a lower rate.
Q. Okay. What were you charging in 2024?
A. $275 an hour.
MR. ANWAR: Okay. I'm going to hand you two documents. I'm going to hand to the court reporter to hand you.
(Document marked for identification as Konikow Exhibit 5.)
(Document marked for identification as Konikow Exhibit 6.)
BY MR. ANWAR:
Q. I will represent to you that -- well, so I've handed you documents that I've

marked as Exhibits 5 and 6. These are copies of bills that -- billing records that were produced to us by your counsel last night.

Are these true and accurate copies of invoices that you've submitted to the lawyers for time that you've worked on this case?

A. Yes.

Q. Okay. And so on Exhibit 5, it says on the first page dates of service October 9, 2024 to October 21, 2024, that your hourly rate was 275, that you worked 19.75 hours, and that the total amount that you charged was $5,431.25; correct?

A. Yes.

Q. Okay. And then the next invoice is dated -- Exhibit 6 is dated, dates of service December 12, 2020 -- excuse me -- December 11, 2024 to December 31, 2024 with an hour -- hourly rate of 275 per hour, total hours 63.58 for a total amount due of $17,484.50; correct?

A. Correct.

Q. Okay. Have you issued any bills for work performed in January yet?

A. Not yet. I hope to get to that

soon.

Q. Okay. Do you have any idea of the total number of hours or the amount of the invoice that you intend to submit for January?

A. Let's see. I would guess it's on the order of 100 hours. I have a record of it at home, but I -- I never added it up because I haven't produced the, you know, I haven't gotten a chance to prepare an invoice for January yet. I hope to do that later this week.

Q. Okay. When you complete that invoice and issue it to your lawyers, we would request that a copy of that invoice be produced.

Is that okay with you?

MR. DEAN: No objection.

BY MR. ANWAR:

Q. And then you mentioned in 2025 your hourly rate has increased to $400 an hour --

A. Yes.

Q. -- correct?

A. Correct.

Q. Have you received any compensation related to Camp Lejeune outside of your paid work as -- currently as a -- as an expert in this

litigation?
A. No.
Q. And I understand that you served on the two ATSDR expert panels on the water modeling; correct?
A. Correct.
Q. And based on the documents that were produced last night, at that time it looks like you were -- you were with the U.S. Geological Service; correct?
A. Survey. Yes.
Q. Survey. Excuse me.
A. Yeah.
Q. And based on the documents that were produced to us last night, it looks like for your participation on the ATSDR expert panels, the U.S. Geological Survey entered into a contract with ATSDR; is that right?
A. Yes.
Q. Okay. Did you receive any compensation individually for your participation in the expert panels?
A. No.
Q. Just your salary as a government

employee?

A. Just I -- yeah, my only compensation was as an employee of the U.S. Geological Survey and, you know, that -- that was it. The contract was between the USGS and ATSDR and I presume to compensate the Survey for my time.

Q. Okay. And based on the information we received or the documents that were produced last night, it looks like you were retained as an expert witness in -- for this litigation in October of 2024; is that right?

A. That's correct.

Q. Okay. And same, based -- based on the e-mails that were produced to us last night, it looks like it was Morris Maslia that put you in touch with Mr. Dean; is that right?

A. That is right.

Q. Okay. How did you come to the decision to serve as an expert witness for the plaintiffs in this litigation?

A. Well, Mr. Dean had contacted me, explained the -- what he was seeking, that he wanted me to serve, you know, to review some documents. I was hesitant because I'm retired,

but he explained the problem, and I had certainly some familiarity with Camp Lejeune and the problem because of my service on those two expert panels.

So I maintained an interest in it. I thought it was an important issue, an interesting problem from many perspectives, but it was, you know, an interesting use of groundwater modeling and transport modeling. And in spite of being retired, I decided, okay, since this would not be a full-time activity for me, I could take this on.

Q. Understood.

A. You know, plus I would be compensated at a, you know, what I thought was a reasonable rate.

Q. Understood.

Now, it was Morris Maslia that introduced you to Mr. Dean; correct?

A. He had contacted me and asked if it was okay for him to give my contact information to a lawyer.

Q. Okay.

A. I don't recall that he mentioned Mr. Dean's name at the time, but he may have. I

don't know.

Q. Okay. How do you know Morris Maslia?

A. I've known him for many years. He used to work for the U.S. Geological Survey. I believe he was an attendee at a training class for which I was an instructor.

The USGS had a fairly extensive training program. We have a National Training Center in Lakewood, Colorado just outside Denver, and I used to be involved as one of the instructors and for a couple of years as the coordinator for a class on solute transport modeling. And I believe Morris sometime way back was a student in that class, and that's probably the first time I met him.

Q. Okay. Around what time frame would that have been when you first met him?

A. It -- it was either the late '70s or early '80s is what I gather or what I would guess or estimate, but I don't recall specifically. I would have to look up attendee lists and things like that, which I may or may not even have. But -- so it was probably in the late '70s to

early '80s, and then I knew at some point he resigned from the Survey and went to work with ATSDR.

Q. Okay. Have you worked with Mr. Maslia on any projects other than the ones at ATSDR related to Camp Lejeune?

A. Not that I could recall.

Q. Do you think of Mr. Maslia as a professional colleague?

A. Yes.

Q. Do you consider him a friend?

A. In a general sort of way, yes. I mean, we -- we've never socialized, but yeah, I consider him a professional friend.

Q. And earlier we discussed the meeting held last week in South Carolina, the two-day meeting, and Mr. Maslia was in attendance; correct?

A. Correct.

Q. Prior to your involvement in this litigation, prior to your retention in October of 2024, when was the last time you had spoken with Mr. Maslia?

A. It was several years before that. I

can't remember exactly when. We had some e-mail communications. Actually speaking with him, I don't recall the last time we actually spoke in a phone call or anything like that. That's probably quite a while, but we did occasionally have e-mail communications.

Q. Understood.

Have you ever served as an expert witness in any other litigation?

A. No.

Q. You mentioned at the beginning of your deposition that you've -- you've been deposed one other time.

A. Yeah.

Q. Can you describe for me the circumstance of, how did that deposition come about?

A. I had done early in my career a lot of work on the Rocky Mountain Arsenal in Colorado where there was pervasive groundwater contamination. Some of the contaminants had migrated beyond the boundaries and affected agricultural lands and farmers north of the arsenal.

I had worked on a project to develop a groundwater flow and solute transport model of that area of the whole problem. I probably worked at least two years full time on that project.

Can you remind me what the question was again?

Q. Sure.

A. (Laugh). I strayed off.

Q. Why were you deposed in the context of that work?

A. Right. So several years after I had completed my work on the Rocky Mountain -- excuse me.

Several years later there, the Superfund law was passed and -- and, you know, things happened. During the time that I was working on the, Shell Chemical Company had been a -- had leased facilities on the Rocky Mountain Arsenal and operated those facilities. I believe their primary activity was manufacturing pesticides and herbicides, as I recall.

Somewhere years, you know, after I had finished my work, EPA or the government was, I believe, suing Shell Chemical for having generated

the waste.

The Department of Justice and some lawyers, I mean, they knew I had done work there. So the DOJ sent people to my office to review everything that I had, I mean, everything in my files, related to the Rocky Mountain Arsenal. And sometime after that, they asked me -- well, either asked or told me -- that they wanted to depose me to give a deposition.

Q. So you were deposed in that instance as what we -- I guess the lawyers would describe as a fact witness; right? You weren't -- you weren't hired as an expert in?

A. I was not hired in any way and to the best of my -- I don't remember the term a "fact witness," but that seems to be a good description of what I was.

Q. You were deposed about your knowledge of the events that had taken place; correct?

A. Correct.

Q. Okay. Now, you submitted your -- your expert rebuttal report in this case in response to the reports of DOJ's -- Department of

Justice's experts; correct?
A. Two experts, correct.
Q. And one of those experts is Dr. Alex Spiliotopoulos; correct?
A. Yes.
Q. And the other expert is Dr. Remy Hennet; correct?
A. Correct.
Q. Okay. Do you know Dr. Alex Spiliotopoulos?
A. Casually. Yes, I do.
Q. How do you know him?
A. Well, he works for Papadopulos & Associates. I believe he attended some of the meetings for the expert peer review panels for ATSDR. I've probably seen him occasionally when I've interacted with Papadopulos & Associates.
Q. Sure.
Do you know Remy Hennet?
A. Yes.
Q. How do you know Remy?
A. I've met him at a -- probably at least twice at social events, dinner parties that we were both invited to.

Q. Okay. Have you ever worked with either Dr. Hennet or Dr. Spiliotopoulos?

A. No.

Q. Do you know a Gordon Bennett?

A. Yes.

Q. Okay. And Gordon Bennett, my understanding is he worked at USGS for many years, and is that right?

A. Yes.

Q. Okay. And then my understanding is then he went on to become a principal at Papadopulos.

Is that consistent with your understanding?

A. After he retired from the USGS, he went to work for one consulting company, I believe in Alexandria, but was not there very long, maybe a year or less than a year. And then after that, my understanding is he went to work for Papadopulos & Associates and worked for them at least 10 years before fully retiring. I don't know if he was a principal or what, but he was an employee certainly.

Q. Sure. Okay.

And is it right, my understanding is Gordon Bennett is considered the father of MODFLOW?
A. Ooh. He played an administrative role in getting it going. I would not have called him the father of MODFLOW.
Q. Okay.
A. He played a role in getting that done in terms of -- I believe he had a big role in hiring the two people or designating the two people, Harbaugh and McDonald, to work on this, and I think administratively he pushed for this to be a project to get this done. So.
Q. So he --
A. But I don't believe he actually worked on the development of the code.
Q. Understood.
Are you generally familiar with SS Papadopulos & Associates?
A. In general, yeah.
Q. Okay. Do you have any opinion about S.S. -- S.S. Papadopulos & Associates?
MR. DEAN: Object to the form.
THE WITNESS: Well, I know

several individuals there, including Stavros Papadopulos. Most of the people working there I do not know. I don't. So I can't have any opinion about them or their work.

Stavros used to work for the Survey -- USGS for quite a while. He left, I believe, in '79 or '80 to form his own company as a consultant.

BY MR. ANWAR:

Q. Within the environmental, you know, based on your experience, within the environmental sort of consulting and, I guess, modeling consulting community, is S.S. Papadopulos from your understanding generally considered a good firm?

MR. DEAN: Object to the form of the question. Asked and answered.

THE WITNESS: Well, again, I think, you know, some of the people there have good reputations and some of the people there I don't know their reputation. Most of the people there I don't know anything about them.

BY MR. ANWAR:

Q. Okay.

A. So it's difficult to -- to say.

Q. Are you familiar with John Doherty?

A. Oh, John Doherty from Australia?

Q. Correct.

A. Yeah, I know the name. I've met him certainly at professional meetings. I remember at least one case at a National Ground Water Association meeting where he was a guest speaker. So, you know, said hello, interacted socially. I know who he is, and I know, you know, kind of what he's done in terms of developing the parameter estimation code called PEST.

Q. Can you talk a little bit about that, what he's done in terms of developing PEST?

MR. DEAN: Object to the form of the question.

THE WITNESS: Well, I know he's the principal author of the software and a book that describes it. How he did it I have no idea or, you know, what he did specifically I have no understanding. I don't know.

The PEST code, I know what it does and I know it's -- it's generally considered a state of the art software tool --

BY MR. ANWAR:

Q. Understood.

A. -- that could be applied for ground -- excuse me -- could be applied to groundwater modeling problems. It's a general code that can probably be applied to any modeling problem, not just groundwater.

Q. Were you aware that John Doherty also now works with S.S. Papadopulos?

A. That he what?

Q. That he's also at S.S. Papadopulos?

A. I'm not sure what you -- could you repeat the question? That he was at?

Q. That John Doherty is now at S.S. Papadopulos?

A. I did not know that.

Q. Okay.

A. That he was. I knew there was some linkage there and I know he had been at their offices, but being -- I had no idea he worked for

the firm as an employee.

Q. Okay. And I think I might have misspoke. I think you're perhaps right.

He used to be at S.S. Papadopulos; correct?

A. I don't know that.

MR. DEAN: Object to the form.

BY MR. ANWAR:

Q. You don't know.

You said --

A. I know he was at the -- in their office.

Q. Okay.

A. I don't know what you mean by "at" Papadopulos & Associates.

Q. Okay. You said he used to be linked to it.

What do you --

A. I know he visited there and, you know, I know he -- it's my understanding or recollection that he taught a short course for them on the use of that, and I think he collaborates or has collaborated with Matt Tonkin, who is an employee of Papadopulos & Associates,

but I have no direct knowledge of what they did or how they did it.

Q. Okay. Aside from responding to their opinions in this case, do you have any opinion about Dr. Spiliotopoulos or Dr. Hennet?

A. No.

Q. Why don't we take a break. I think this is a good place --

A. Good idea.

Q. -- to take a break. We've been going over an hour.

THE VIDEOGRAPHER: We're going off the record. The time is 11:06 AM.

(A recess was taken.)

THE VIDEOGRAPHER: Back on the record the time is 11:15 AM.

BY MR. ANWAR:

Q. We are back on the record from a short break.

Dr. Konikow, are you okay to continue?

A. Yes.

Q. Okay. During the break, did you speak with your -- your lawyers about the

substance of your testimony at all?
A. No.
Q. Okay. Before the break, we had just wrapped up a conversation about John Doherty.
Do you recall that?
A. Yes.
Q. One other question occurred to me that I wanted to ask.
I noticed in the documents that were produced last night in response to the subpoena, there was a document where you passed along Doherty's -- John Doherty's contact information to Mr. Dean.
Do you recall that?
A. Yes.
Q. Do you know, what is your understanding about why you passed that contact information along?
A. Well, I believe he asked me if I had contact information --
Q. Okay.
A. -- for John Doherty, and I had some information and so, you know, I sent it to him.
Q. Okay. Do you know what came of

that?

A. No.

Q. Okay. Have you -- when is the last time you've spoken with Mr. Doherty?

A. Several years ago. Probably four or five years ago.

Q. Okay. Understood.

A. Yeah.

Q. Now, we discussed earlier you served on ATSDR's expert panel on the Camp Lejeune water modeling; correct?

A. Correct.

Q. Okay. And there was an expert panel in 2005; correct?

A. Correct.

Q. How did you come to serve on the 2005 expert panel?

A. Somebody asked me, and I would -- I would guess that it was probably Morris asked if I'd be interested in doing that. I don't recall exactly who or when I was asked or how I was asked, but I would guess it was probably Morris.

THE VIDEOGRAPHER: Counsel, could you please put on your mic?

BY MR. ANWAR:
Q. What do you remember about the 2005 expert panel?
A. I remember they -- I think they had asked us some questions in advance before meeting, maybe four to six questions to get our preliminary opinions. I think they had sent us some documents or draft reports to review to prepare for it.
I remember, you know, going to Atlanta. There were two days of meetings. There were, you know, a fair number of people in the audience, maybe -- I don't know -- 10 to 20 at different times, maybe a few more.
I think there were probably something on the order of 10 people on the expert panel. May have been 12. I don't recall exactly. We had meetings. We had presentations made to us about what was expected of the committee.
And then we had technical presentations from people such as Morris, Bob Faye and others about the background of the situation, the hydrogeologic framework, the groundwater flow systems, the contaminant sources, and basically everything related to that.

So there were technical presentations. The committee members asked questions. I think towards the end we met in a closed session, and I believe we came to a consensus of our assessments.

I can't recall specifically what follow-up, if any, was done after the second day of the meeting.

Q. Thank you. That's helpful.

Do you recall what draft documents you were provided to review in advance?

A. I do not recall which ones, but I -- I'm -- I would guess it was preliminary versions of some of the reports that were eventually published, but I don't recall.

Q. What did you understand about the purpose of the ATSDR water modeling for Camp Lejeune heading into the 2005 expert panel?

A. Well, my understanding I believe then was similar to my understanding now that the purpose of the modeling was to estimate what the concentrations were coming out of the Water Treatment Plant and going into the distribution system.

Q. And that was in support of a population level epidemiology study; right?

A. I knew there were epidemiological studies that would be done and that, I presume, would use the information from the -- from the models. I have no knowledge of any of the epidemiological studies, how they were done or what the results were. I don't have that information.

Q. Sure.

And that 2005 expert panel, that took place over two days in March 2005; right?

A. I presume so. That sounds about right.

And, again, the other thing I believe is that it focused on the Tarawa Terrace situation.

Q. Okay. And you said it took place in Atlanta.

Did it take place at ATSDR's facilities?

A. That's my recollection. That we went into a CDC campus, and they brought us over to an ATSDR facility, I think, but I don't recall.

I remember there was a gate, and we had to go in and get, you know, approved to go into the facility and then were directed somewhere, but I don't remember those, any more details than that.

Q. Sure.

You mentioned Morris Maslia and then Robert Faye, or Bob Faye.

Who is Bob Faye?

A. Bob Faye? He's a person who, when I first met him, he worked for the U.S. Geological Survey. I believe his position was as a regional groundwater specialist, and at the time the Water Resources Division of the U.S. Geological Survey was divided into four regional offices.

The Southeast Region was headquartered in Atlanta, and my recollection is that for that regional office, Bob Faye was considered the -- or had the position of being the regional groundwater specialist.

So reports or any other issues dealing with groundwater that came up in any of the district offices in the Southeast Region, if there was some issues, Bob Faye would be the regional groundwater specialist is the one who

would assess, comment on, evaluate any problems or issues.

Q. Understood.

Do you remember who any of the other members of the expert panel were? The 2005.

A. The 2005 panel.

I, you know, I looked at the list of members probably a week or two ago, but I just -- I can't remember who was on the 2005 panel.

Q. That's okay. Fair enough. Thank you.

You were an expert on the 2005 expert panel; correct?

A. Correct.

Q. Now, you mentioned it was focused on ATSDR's water modeling efforts -- the 2005 panel was focused on ATSDR's water modeling efforts related to Tarawa Terrace; correct?

A. That's my understanding, yes.

Q. Do you recall whether there was any discussion about the Hadnot Point/Holcomb Boulevard modeling at that time?

A. Of the modeling? I doubt it, but of

the existence of Hadnot Point/Holcomb Boulevard, I'm sure that was mentioned.

Q. Did you provide feedback or input about the -- about ATSDR's water modeling efforts related to Tarawa Terrace in 2005?

A. I'm sure I did.

Q. Do you recall what that feedback or input was?

A. Well, specific explicit comments I can't recall. I recall, you know, the -- you know, I'm sure I had questions about parameter values and how they did this or why they did it this way. I'm sure there was a lot of questions, comments and, you know, issues.

I know the bottom line at the end, the expert peer review panel felt very positive about what they were doing in the sense that I think the consensus of the expert peer review panel was that the work being done by ATSDR for groundwater modeling flow and transport was state of the art and excellent work, reliable work.

Q. Okay. Were there any concerns expressed at the 2005 expert panel?

A. I'm sure there were.

Q. Why do you say you're sure there were?

A. Well, our job was to critique and review everything they done -- did and we would, you know, question, why did you do this? Or where did you get that value from? Or what's the basis of this? Again, I can't recall specific questions. If I thought about it, maybe I could.

But I know I had some concerns about numerical dispersion in the transport model, about the representation of model layer 1. You know, I remember these were some of the specific issues that concerned me before I could get any response back from them, but I felt overall that they addressed all of the concerns that I had.

Q. Do you recall if any of the other members of the expert panel expressed concerns or critiques about the Tarawa Terrace efforts?

A. I can't recall.

Q. Okay. Now, you also served on the expert panel held by ATSDR on Camp Lejeune water modeling in 2009; right?

A. Correct.

Q. Okay. And how did you come to serve

on the 2009 expert panel?

A. I assume someone asked me to serve on it. I, you know, again, I -- I assume Morris had some role in inviting me, but I don't know that. You know, I just don't recall.

Q. Okay. What do you remember about the 2009 expert panel?

A. It focused on the Hadnot Point/Holcomb Boulevard areas and the models developed for that area. There probably was some discussion of Tarawa Terrace, but the main focus was on Hadnot Point/Holcomb Boulevard.

I remember Mary Hill was on that panel. Dave Dougherty was on that panel. But, again, I looked at the names the other day and I just can't remember right now who else was on it, but, you know, again there were probably 10 to 12 experts on the panel.

Q. Sure.

And that panel took place over two days in 2009?

A. Exactly, yes. Correct.

Q. Was there a Mr. Jerry Ensminger on -- that participated in that expert panel?

A. My recollection that's the name of a Marine who was -- I remember there was one Marine in the audience, and he was given a chance to speak. I believe that's the name that you gave, but I can't -- I'm not absolutely certain.

Q. You said he was in the audience and he was given an opportunity to speak?

A. That's my recollection.

Q. Okay. Mr. Ensminger is not a modeling expert or an epidemiologist, to the best of your knowledge?

A. Correct.

Q. Was there a Mr. Mike Partain that attended the expert panel as well?

A. I don't recall that name.

Q. Okay. Did you provide feedback about the Hadnot Point/Holcomb Boulevard modeling efforts at the 2009 expert panel?

A. I'm sure I did. That's why I was there.

Q. Do you recall the feedback that you provided?

A. I know initially I came in with some skepticism, which is, you know, normal in any

technical review, and I had some concerns about how well they could define the source terms and the timing. Specific comments I don't recall.

Q. Do you recall any comments from other members on the expert panel?

A. Not that I -- I do not recall specific comments.

THE VIDEOGRAPHER: Counsel, do you need help with your mic?

MR. ANWAR: Excuse me?

THE VIDEOGRAPHER: Do you need help with your mic?

MR. ANWAR: Yeah, I'm fixing it.

THE WITNESS: I don't recall specific comments of the other participants off the top of my head.

BY MR. ANWAR:

Q. Okay. Were there -- do you recall any critiques or concerns about performing the Hadnot Point/Holcomb Boulevard water modeling?

A. Well, yeah. I mean, I know I had some concerns but, you know, again I think they addressed my concerns.

Q. What were your concerns?
A. Well, one of the concerns was compared to Tarawa Terrace where there was believed to be one single source of contamination and its location was pretty well known and the contaminant was pretty well known and the timing of it was pretty well known, looking at the Hadnot Point/Holcomb Boulevard, there seemed to be multiple sources just spread out over the industrial areas and the landfill areas and that they could not be defined with the same precision that the source term on the Tarawa Terrace area could be defined. So this was a concern.
Q. Okay. Did you --
A. For --
Q. Go ahead.
A. I was going to add that, you know, for both of them, there was, you know, no observations of concentration for a period of years before the problem became recognized, you know, that's an issue that has to be addressed.
Q. Sure.
There -- there were observed contamination levels or samples taken in 1982 and

1985 at Camp Lejeune; right?

A. I believe so, and maybe, you know, in between. There may have been some '83, '84 I believe, but I don't recall the exact dates. But that sounds about right.

Q. Okay. And the ATSDR modeling efforts related to Tarawa Terrace and Hadnot Point and Holcomb Boulevard, they were attempting to reconstruct historical contamination levels, monthly contamination levels dating back to 1953; correct?

MR. DEAN: Object to the form.

THE WITNESS: 1953 for Tarawa Terrace, but I believe earlier for Hadnot Point and Holcomb Boulevard.

BY MR. ANWAR:

Q. And the earliest available data during that period was 19 -- and when I say "available data" what I'm specifically referring to is observed contaminant concentration levels of sampling data.

The earliest data available during that time was 1982; correct?

A. Yes, that's the observed, but I also

view the assumption at the start of the simulation before there was any as equivalent to an observed level of no contaminant in the aquifer as a known condition. Even though there were no samples that showed it was zero before 1953, that seemed like a pretty reliable and accurate assumption.

Q.   What is the assumption that you're referring to?

A.   That you have to -- in developing the model -- and they started with Tarawa Terrace in 1953. To solve any governing partial differential equation, which is what the numerical models do, you have to define boundary conditions and initial conditions.

Definition of the initial conditions for the solute transport model are the concentration distribution of the solute of concern at times zero, which would be 1953.

And inherently there's an assumption that it was zero before any contaminant was introduced, and that is a very reasonable, logical assessment of the initial condition in terms of what the concentration distribution was at that time, which is zero.

Q. Understood.
But for the period prior to 1982, there were no historical observed concentration level data; correct?
MR. DEAN: Object to the form.
THE WITNESS: Not that I'm aware of.
BY MR. ANWAR:
Q. Besides serving on these two expert panels, the one in 2005 focused on Tarawa Terrace and the one in 2009 more focused on Hadnot Point/Holcomb Boulevard, did you contribute or do any work related to ATSDR's water modeling efforts for Camp Lejeune?
A. No.
Q. I saw that you're not listed as an author on any of the reports; right?
A. Correct.
Q. You weren't involved in writing the reports?
A. Not at all.
Q. And you didn't perform any of the data collection or the field testing; right?
A. No, I did not.

Q. Okay. Have you ever visited Camp Lejeune?

A. No, I have not.

Q. And earlier in your deposition I think we discussed that at that time you were -- that you served on the -- the two expert panels, you were employed by the U.S. Geological Survey; correct?

A. Yes.

Q. And so other than your salary as an employee of the U.S. Geological Survey, you were not compensated at all to participate in the -- the 2005 or 2009 panels; correct?

A. That's correct.

MR. ANWAR: Okay. I'm going to mark an exhibit. I'm handing to the court reporter what is being marked as Exhibit 7.

(Document marked for identification as Konikow Exhibit 7.)

MR. DEAN: Can we agree that this is not the entire book? Just select to.

MR. ANWAR: We can agree this

is not the entire book.

BY MR. ANWAR:

Q. I've handed you an exhibit that I've marked as Exhibit 7. This is -- this is an excerpt from a book entitled "The Handbook of Groundwater Engineering"; correct?

A. Yes.

Q. And you're familiar with this book; right?

A. I haven't looked at it in years, but I was a coauthor of that chapter. So yes.

Q. Okay. The book itself was published in 1999; right?

A. (Reviews document.)

It says 19 -- yeah, it says copyright 1999.

Q. Okay. And you just mentioned you coauthored that chapter.

You coauthored Chapter 20 on "Groundwater Modeling"; right?

A. Yes.

Q. Okay. And you coauthored it with a gentleman named Thomas E. Reilly?

A. Correct.

Q. Who is Thomas E. Reilly?

A. Tom was a groundwater scientist or engineer that worked with the U.S. Geological Survey. I knew him as a colleague from the USGS. We were in the -- we overlapped in the same office for a while in the -- I think it's called the Office of Groundwater, which was kind of a headquarters quality assurance type of group.

Tom moved -- he had worked on Long Island, New York in the Long Island office for many years. Then he moved to Reston to join us headquarters group. Then I left that to join the research program, and several years later Tom did the same thing and was in the research program. We were colleagues there. Then he moved back into the Office of Groundwater after a year or two in the research program.

So, you know, we were colleagues, you know, knew each other, and I had invited him to help me prepare this chapter on "Groundwater Modeling." He had more expertise on finite element methods than I did and I thought he was, you know, well-known and well-rounded in groundwater modeling technique. I thought it

would be very beneficial to have him as a coauthor.

Q. Understood.

And the words in this chapter in Chapter 20 are yours and his; right?

A. Yes.

Q. Okay. I wanted to ask you a few questions about Section 20.1 in Chapter 20, which is the Introduction.

The opening line in the chapter reads:

"Effective management of groundwater requires the ability to predict subsurface flow and transport of solutes, and the response of fluid and solute flux to changes in natural or human-induced stresses."

Did I -- did I read that correctly?

A. Yeah. Yeah.

Q. What do you mean by "effective management of groundwater"?

A. Well, I mean, groundwater is a resource. It's, you know, used to the benefit of society, also to the benefit of individuals and benefit of cities, benefit of factories, benefit

of agricultural. You know, there's just multiple uses.

It's a resource that should be managed and it's a resource that in many cases throughout the U.S. and the rest of the world is not managed at all. Because people -- a landowner could drill a well and pump out as much water as they want, in some cases without anyone overseeing their use of the resource.

In the U.S. that varies greatly by state to state. In some areas, particularly if there have been some problems or limitations on the use, it's been overdeveloped, then they form management districts or laws are implemented in a state or in a county to try to, well, in effect, manage the resource and try to assure that it lasts longer as a resource, as a usable resource than it would if there was no limitations on development.

So by "effective management," we're really implying that there is some management structure governing the use of groundwater that's there for basically the benefit of society and the common good. And, you know, I guess in our

opinion, the effective management, management that is efficient and effective in trying to assure the sustainability of a groundwater resource in an area is just a necessary and valuable imposition of some controls on the use of the resource, but it's not done everywhere.

Q. Understood.

Does management entail planning?

A. Management should involve planning, thinking ahead, yeah. If they're not thinking ahead, then they're not doing a good job managing it.

Q. And that I think you mentioned -- I can't recall if it was scarcity or conservation of water.

Is it management of?

A. Well, I think I put it in the terms of sustainability.

Q. Sustainability, correct.

A. And, you know, that's easier to do in some areas than in others.

Q. Sure.

If you turn the page to Chapter 20.2 on page 20-2, it's a subsection entitled "Models";

right?

A. Okay.

Q. And the first couple sentences there:

"The word 'model' has so many definitions and so overused that it's sometimes difficult to discern its meaning."

And then there's a citation to you and I think Fred Bredehoeft?

A. Bredehoeft. Bredehoeft.

Q. Bredehoeft.

And then the next line:

"A model is perhaps most simply defined as a representation of a real system or process. A conceptual model is a hypothesis for how a system or process operates."

Did I read that correctly?

A. Yes.

Q. Okay. And so a model is a simplified representation of a real world system or process; that's what you're saying there?

A. That's what we said.

Q. Okay. And a conceptual model is a hypothesis for how a system or process operates;

right?

A. In effect. It's a -- it's a verbal description of your understanding.

Q. And the --

MS. BAUGHMAN: Were you finished, Dr. Konikow?

THE WITNESS: Well, I was just going to add: As a verbal description, it could be either qualitative or quantitative.

BY MR. ANWAR:

Q. Okay. And the start of the next paragraph there it says:

"Most groundwater models in use today are deterministic mathematical models."

Right?

A. That's what it says, yes.

Q. Okay. What -- what is a deterministic model?

A. A deterministic model is one in which the solution, the result is, in effect, predetermined by the solution to a governing equation. You have a mathematical equation that describes quantitatively your understanding of the

processes that govern, let's say, groundwater flow, and to solve the differential equation, you need to define boundary conditions and initial conditions and the solution to that, the results.

It's not random. It's predetermined by the parameters you put in and the nature of the equation and your definition of initial and boundary conditions and, you know, if one person does it here and another person does it there, if they have all the same parameters and the same equation, they should get the same results.

Q. Got it.

The next line in that second paragraph says:

"Deterministic models are based on conservation of mass, momentum, and energy and describe cause and effect relationships."

Right?

A. Yes.

Q. Okay. And what does "conservation of mass, momentum, and energy" mean?

A. Okay. These are basic thermodynamic principles that, you know, if you have a certain volume of water coming into a box, or an aquifer

or some kind of element, masses can serve that's neither created nor disturbed, destroyed, except for radioactive constituents and, you know, what goes in has to be balanced by what comes out or what the mass and storage in that unit changes.

Q. Does that mean that in a deterministic model, the mass, momentum, and energy remain constant throughout time?

A. No.

Q. Okay.

A. It just means that, you know, if you add mass to the system at some later time, then it all has to be balanced.

Q. I got you.

A. Yeah.

Q. So if we turn to -- well, it's on the same printed page, but the next page of the book is subsection 20.3 Flow and Transport Processes.

A. Yes.

Q. I wanted to ask you about the -- that first line says or the first line of the second paragraph -- paragraph:

"The purpose of a model that

simulates solute transport in groundwater is to compute the concentration of a dissolved chemical species in an aquifer at any specified time and place."

Is that right?

A. I believe so.

Q. Okay. And then if we jump ahead a little bit to the paragraph at the end of that section starting with "The subsurface," it says:

"The subsurface environment constitutes a complex, three-dimensional herogeneous hydrogeologic setting. This variability strongly influences groundwater flow and transport, and such a reality can be described accurately only through careful hydrogeologic practice in the field."

Did I read that correctly?

A. Yeah. The word "heterogenous" was on the first line.

Q. Oh, hetero. Yeah, heterogenous.

A. Yes, you read it correctly.

Q. Okay. These are your words, so you'll agree with that; right?

A. Yes.

Q. Okay. And then "However" the next sentence in that same paragraph.

"However, regardless of how much data are collected, uncertainty always remains about the properties and boundaries of the groundwater system of interest."

Why -- why does uncertainty always remain?

A. Well, the subsurface environment, basically the geologic framework of an aquifer due to geologic processes, its properties and characteristics of permeability, porosity and so on just vary in space because of the geologic processes that led to the deposition of material and its geologic modification subsequent to its deposition, its burial by under sediments and so on.

And these are complex patterns and they're underground. You can't look at them directly. So there you could use geophysical methods to try to find out different characteristics, change in space, but there's limitations to how accurate that is.

You use wells to observe at a point,

but whatever you define at that point, the properties could be a little different 10 feet away or maybe even more than a little different.

In other words, it's out of sight out of the ability of us to see underground to completely characterize all the properties of the system. It's, you know, it just can't be done with present -- certainly not with present technology.

Q. Understood.

A. And so we do the best we could, interpolate between points where we have more data, and then build that into a model.

Q. And there's no way to create a model that perfectly recreates reality; right?

A. That's my belief.

Q. Okay. And you just explained it, but a large part of that is because there are aspects of the subsurface that we don't know about; correct?

MR. DEAN: Object to form.

THE WITNESS: We --

MR. DEAN: You can continue.

THE WITNESS: Yeah.

That we can't observe directly within any kind of feasible economic framework. I mean, if you drill more and more wells to observe more and more spaces, pretty soon the wells themselves are increasing the porosity of the aquifer.

So there's a limit to how much we could do, and certainly it's expensive to drill one well. So you never have a budget to drill an infinite number of observation wells.

BY MR. ANWAR:

Q. And are subsurface conditions -- I guess for lack of a better way of saying this, are subsurface conditions changing based on sort of the environmental conditions surrounding them?

A. The hydraulic properties very rarely would change in time on a human time frame. That just doesn't happen. The hydraulic conditions in terms of pressure distributions and water levels, those certainly can change quickly.

Q. Okay. How groundwater modeling and transport is typically used for planning and

management purposes; right?

MR. DEAN: Object to form.

THE WITNESS: Can you repeat that?

BY MR. ANWAR:

Q. Groundwater -- groundwater modeling is typically used for planning and management purposes; right?

MR. DEAN: Same objection.

THE WITNESS: Well, typical uses of groundwater models? I wouldn't say it's typical for that. Models are used for management purposes, but they're used for many other purposes, and I don't know which purpose is more typical.

BY MR. ANWAR:

Q. What are some of the management purposes that models are used for?

A. I think the first highest level use is to understand the system to help. Good management of the system requires that you understand the system and understand which way groundwater is flowing, what the head distribution is, and how the whole system operates. How to

predict the effects of drilling a new well and pumping it at a specified rate might impact other users. It might impact the water table and the sustainability of the resource. The model allows you to do that in a quantitative way.

Q. And to understand the system, that could be one of the purposes of sort of a model or uses of a model would be to project water needs in the future for -- for agriculture; right?

A. Well, not to project water needs, but to project the impacts of water use. You wouldn't use the model -- a groundwater model to predict water use. You would use it -- you would predict water use some other way based on economic, climate, whatever.

There you would estimate water use, and then you could say, what would happen to the system if this water use is implemented in the future? And the model could then help you assess what the impacts of a proposed water use would be.

Q. Okay. That's really helpful.

And then a model can also be used to estimate the movement of contaminants for remediation efforts; right?

A. Certainly.

Q. Now, I'd like you to take a look at your rebuttal report. It's Exhibit 2.

Okay. So looking at the first paragraph under Introduction on page 1, it says there that:

"ATSDR prepared reports describing models developed to stimulate groundwater flow and contaminant transport at two areas of Camp Lejeune, North Carolina: Tarawa Terrace and then Hadnot Point/Holcomb Boulevard area."

Correct?

A. Yes.

Q. And when we're talking about ATSDR's Camp Lejeune water modeling efforts -- I think this has been clear already, but I just want to confirm.

When we're talking about ATSDR's Camp Lejeune water modeling efforts, we're really talking about two separate water models; correct?

A. Correct.

Q. ATSDR completed a water model related to Tarawa Terrace; right?

A. Yes.

Q. And my understanding, at least of the last report, it was completed around 2009.
Is that consistent with your understanding?
A. I believe so. I don't remember the dates on the reports, but that sounds about right.
Q. Okay. And for Tarawa Terrace, ATSDR performed a groundwater model using MODFLOW; right?
A. Correct.
Q. And then they performed a fate and transport model using MT3DMS; right?
A. Yes.
Q. Is there -- the general uncertainty that we just discussed in terms of flow and transport processes, does that exist for groundwater models as well?
MR. DEAN: Objection.
BY MR. ANWAR:
Q. For -- for flow models?
MR. DEAN: Object to the form.
THE WITNESS: Well, groundwater flow models such as MODFLOW --

BY MR. ANWAR:

Q. Yeah.

A. -- assume that the changes can be described by a governing equation that is fairly standard, well accepted by scientists and engineers. You know, it's pretty common.

Parameters values, in other words, the equation has coefficients in it, and those coefficients need to be described in order to solve the equation. Those coefficients include hydraulic properties such as hydraulic conductivity, the saturated thickness, how you discretize the system, storage coefficients or specific yields. If it's a transient flow problem.

But, you know, one of the primary is hydraulic conductivity, but you could also sometimes refer to as transmissivity if you account for the saturated thickness of the layer.

So you need to describe these and, again, as with any other geologically based parameter or property, yes, there is uncertainty.

Q. And I guess I was wondering.

When you -- so for the Tarawa

Terrace model, MODFLOW was used for the groundwater flow model and MT3DMS were used -- was used for the fate and transport model and then they were linked together; correct?

A. Well, yeah, there's a linkage between the two, but it's not necessarily, you know, one integrated model.

Generally what is done, at least for those codes, for MT3D, is you run the flow model first and you generate a very large file that has all the heads and specific discharges, all the fluxes, and then you run -- afterwards you run MT3D and the MT3D reads the file. There's some linkage file that connects MT3D with the data that was produced by the flow model.

Q. I guess my -- my question is that if you use MODFLOW, a MODFLOW-based flow model and with an MT3D-based flow and transport model, with both models having some level of uncertainty, when you use them -- when you use them together, does that uncertainty sort of -- does it become cumulative?

A. No, I wouldn't say that, but I would correct you. MT3D is not a flow model.

Q. Oh, I'm sorry.
A. So it's just a solute transport model. It uses the flows or fluxes that are output or calculated by MODFLOW.
Q. Okay. I think that's what I meant was it's a transport model; correct?
A. It's a transport model, and I would not say that the, you know, uncertainty is cumulative in any way.
Q. Okay. And for the Hadnot Point/Holcomb Boulevard water modeling effort, that was separate from Tarawa Terrace; right?
A. That's my understanding.
Q. Okay. And that was completed around 2013; right?
A. That's my understanding.
Q. And for that -- for Hadnot Point/Holcomb Boulevard, ATSDR again used MODFLOW for the groundwater flow model; correct?
A. I believe they used a newer version of MODFLOW than was used in the Tarawa Tara list -- Terra -- Tarawa Terrace model.
Q. Okay. And for the transport model, they used MT3DMS --

A. Yes.
Q. -- again; right?
A. Yes.
Q. And then this time they also used a water distribution model EPANET to simulate intermittent connections between Hadnot Point and Holcomb Boulevard; right?
A. Yes.
Q. Okay. To the best of your knowledge, did ATSDR perform water models for any other water distribution systems at Camp Lejeune?
A. At Camp Lejeune? Not that I'm aware of.
Q. Okay. Now, looking at your report, going back to your report, the next line after that first sentence we -- we just discussed is:
"Their use of the models was innovative in the sense that instead of a typical use of a groundwater model to predict future behavior, they used the model to 'predict' how the system evolved in the past (before concentration observations were made) from a known state (an initial condition), in which no contaminants were present, to a contaminated aquifer with a mapped

distribution in the early to mid-1980s when contamination was observed at a number of locations (wells, soils samples, and water treatment plants)."

Did I read that correctly?

A. Yes.

Q. My question was about -- I guess my question was a moment ago I asked you whether models are typically used -- I guess groundwater flow and transport models are typically used for planning or groundwater -- groundwater management purposes, and I think you said you weren't sure whether they were used typically or not typically for that purpose.

Is that a fair assessment?

A. Yeah, it's --

MR. DEAN: Hold on.

Object to form of the question. Misstates his prior testimony.

BY MR. ANWAR:

Q. Was that a fair characteristic -- characterization of your testimony?

A. Yes.

Q. Okay. And so here you say that the

ATSDR models were "innovative in the sense that instead of a typical use of a groundwater model to predict future behavior."

Groundwater and transport models are typically used to predict future behavior; right?

A. Very often or to help understand present behavior.

Q. And the ATSDR model, you know, here in your report is innovative in the sense that it was being used to predict past concentration levels for which real world observed concentration level data wasn't available; correct?

MR. DEAN: Object to the form.

THE WITNESS: Well, the objective -- primary objective seemed to be that historical reconstruction. That's, I'd say, typically not the main objective, but I didn't mean to imply that -- that what you call historical is never done. It's actually commonly done, but not as the main purpose of the model.

BY MR. ANWAR:

Q. Can you elaborate on that a little bit? When you say you didn't mean to imply that

it's not commonly done but not the main purpose of the model, what do you mean by that?

A. What I mean is, for the Tarawa Terrace, it seemed like a main objective in terms of computing the concentrations over time. A main focus was on reconstructing that concentration distribution in that period in which there were no data prior to 1982.

That the solution of the governing equation for a period in which there's no observation is actually very common in transport models -- in contaminant transport models because it's very common that there's a period of record in which there is no observations.

For groundwater contamination problems, people generally are not aware it's a problem until it shows up someplace where it doesn't belong.

A well is contaminated. Someone is, you know, drinking. Then all of a sudden people recognize a problem. Then they start making measurements and observations, but groundwater moves slowly. So that could be 10, 20, or 30 years before the problem is recognized and

observations are made.

If you're going to model that system, you have to start back at time zero before any contaminants are introduced, and so it's very common that, you know, you would be doing essentially the same thing, but it's very often not called historical reconstruction.

Q. Understood.

The -- I think earlier in your deposition we discussed that the ATSDR models were attempting to reconstruct population level monthly contaminant concentrations for use in an EPI study; right?

MR. DEAN: Object to the form of the question.

THE WITNESS: Well, I mean, I don't know about population level studies. I'm not even sure what that means.

But we were aware that the groundwater modeling would be used for epidemiological studies.

BY MR. ANWAR:

Q. Okay. And I think I misspoke.

What I meant to say was the ATSDR models were used to reconstruct or estimate past monthly concentration levels to support a population level epidemiological study; right?

MR. DEAN: Object to the form of the question.

THE WITNESS: Yeah. Well, everything you said after "support" I'm not sure about, but yes, the models were used to reconstruct the concentrations distributions throughout the aquifer prior to 1982.

BY MR. ANWAR:

Q. Okay. Are you aware of any other models besides AT -- or strike that.

Are you aware of any models attempting to reconstruct historical contaminant concentration levels for the purpose of determining exposure in individuals?

MR. DEAN: Object to the form.

Are you talking about Camp Lejeune or just in general?

MR. ANWAR: I asked about any models.

MR. DEAN: Okay.

BY MR. ANWAR:

Q. Are you aware of any modeling attempting to reconstruct historical contaminant concentration levels for the purpose of determining exposure in human individuals in real life?

A. For that purpose in real life? No. I mean, I would say modeling at the WIPP site was used to predict future exposure, and then they were health studies or assessments made on that, but that was all hypothetical a thousand years in the future. But that's what the modeling was done. It was related to exposure of a future farmer living downstream. So yes, that was done there.

I'm aware of many studies where that historical reconstruction was done but not for the purpose of exposure.

Q. Okay. And during that WIPP study, did that model into the future actually simulate estimated concentration levels?

A. Yes.

Q. It did?

A. Yes, but not -- the model itself did not get into the health and exposure issue. It just computed the concentrations how they would spread under a hypothetical breach of the repository.

Q. And then what was that information used for?

A. As part of a safety assessment for the proposed radioactive repository, and all of those analyses were included in the safety assessment that was submitted to EPA to get an operational license for the site, and that approval was granted somewhere in the mid-1990s or late 1990s.

Q. Okay. Now, jumping back to Exhibit 7, which is Chapter 20 of your book. Yeah, Chapter 20. Your Chapter 20 of the book that we looked at.

I'd like to ask you a few questions about section 20.6.

A. Okay.

Q. That subsection is titled "Model Design, Development, and Application"; right?

A. Yes.

Q. And the first sentence there in your book -- excuse me -- in your chapter that you coauthored states:

"The first step in model design and application is to define the nature of the problem and the purpose of the model."

Right?

A. Yes.

Q. Okay. And those are your words; right?

A. Well, mine and Tom Reilly's.

Q. Okay. But you don't disagree with those words; right?

A. Nope.

Q. Okay. Why is defining the nature of the problem and the purpose of the model the first step?

A. Well, you have to know the nature of problems to know before you decide what the best form of a model is to simulate it. Knowing the purpose of the model, what it would be used for, helps you assess what factors should be included and what could be safely ignored.

Q. Understood.

And so if we go on, it says:
"Although this may seem obvious, it is important -- it is an important first step that is sometimes overlooked in a hasty effort to take action. This step is closely linked with the formulation of a conceptual model, which again is required prior to development of a mathematical model."
Did I read that correctly?
A. Yes.
Q. Okay. And those are words that you coauthored; right?
A. Excuse me?
Q. Those are words that you coauthored; right? Those are your words; right?
A. Yes.
Q. Okay. And you still agree with what's said there; correct?
A. I believe so. Yes.
Q. And then if we jump to the end there or if we go a little further down in the paragraph, starting with the sentence that says "Good judgment."
"Good" -- do you see where I'm at?

A. Yeah, I could see it.
Q. Okay.
"Good judgment is required to evaluate and balance the trade-offs between accuracy and cost, with respect to model development, model use, and data requirements. The key to efficiency and accuracy in modeling a system probably is more affected by the formulation of a proper and appropriate conceptual model than by the choice of a particular numerical method or code."
Did I read that correctly?
A. You did.
Q. Okay. And do you agree with that statement?
A. Yes.
Q. Okay. And in particular, the key -- what it says there is that the key to efficiency and accuracy in a modeling system is more affected by the formulation of a proper and appropriate conceptual model; right?
A. Yes.
MR. ANWAR: Okay. I'm going to hand -- I'm going to hand you what I

am marking as Exhibit 8.

(Document marked for identification as Konikow Exhibit 8.)

BY MR. ANWAR:

Q. Exhibit 8 is the "Chapter A: Summary of Findings" for ATSDR's Tarawa Terrace water model; correct?

A. Yes.

Q. Okay. If you turn to -- it's page Roman numeral III. Just a couple pages in. Under the Foreword.

A. Yes.

Q. You see that?

A. Yes.

Q. It says:

"ATSDR, an agency of HHS, is conducting an epidemiological study to evaluate whether in utero and infant (up to 1 year of age) exposures to volatile organic compounds in contaminated drinking water at U.S. Marine Corps Base Camp Lejeune, North Carolina, were associated with specific birth defects and childhood cancers. The study includes births occurring during the 19 -- during the period 1968 to 1985 to women who

were pregnant while they resided in family housing at the base."

Did I read that correctly?

A. Yes.

Q. And as we discussed before, the ATSDR's water model for Tarawa Terrace was developed to obtain estimates of historical exposure for the EPI study that they were performing --

MR. DEAN: Object.

BY MR. ANWAR:

Q. -- correct?

MR. DEAN: Object to the form of the question.

THE WITNESS: Well, I don't know that it was developed that the models would calculate exposures. The models would calculate the concentration distribution in time and space.

BY MR. ANWAR:

Q. The -- if we go to the next paragraph just underneath, it says:

"Historical exposure data needed for the epidemiological case-control study are

limited. To obtain estimates of historical exposure, ATSDR is using water-modeling techniques and the process of historical reconstruction."

Did I read that correctly?

A. You did.

Q. And that was the purpose of ATSDR's model for Tarawa Terrace; correct?

A. Well, yeah. I think the next sentence that you didn't read is critical also.

These -- these methods, the water modeling techniques, "are used to quantify concentrations of particular contaminants in finished water and to compute the level and duration of human exposure to contaminated drinking water."

So I think that's a key part of it.

Q. Sure.

But that -- that was the purpose?

A. Yeah.

Q. What we both read; correct?

A. Yes. Yes.

Q. Okay. Now, if you turn to page -- well, let me -- let me -- one question before we turn the page.

Per the first paragraph, the EPI study that was being performed was for the period between 1968 and 1985; correct?
A. Apparently, yes.
Q. Okay. And if we turn the page to A98.
A. To which page?
Q. A98.
A. A98.
Q. This is a -- this is part of a Q&A about the Tarawa Terrace model and there's a question there. The last question on A98 says:
"ATSDR's historical reconstruction analysis documents that Tarawa Terrace drinking water was contaminated with PCE that exceeded the current maximum contaminant level (MCL) of 5 milligrams per liter during 1957 and reached a maximum value of 183 micrograms per liter. What does this mean in terms of my family's health?
Did I read that correctly?
A. Yes.
Q. Okay. And the answer is:
"ATSDR's exposure assessment cannot be used to determine whether you, or your family,

suffered any health effects as a result of past exposure to PCE-contaminated drinking water at Camp Lejeune."

Did I read that correctly?

A. Yes.

Q. And it goes on to say:

"The study will help determine if there is an association between certain birth defects and childhood cancers among children whose mothers used this water during pregnancy. Epidemiological studies such as this help improve scientific knowledge of the health effects of these chemicals."

Did I read that correctly?

A. Yes.

Q. And, again, per this information here, the model -- the -- the estimated monthly concentration -- contaminant concentration levels were for the purpose of epidemiological studies; correct?

MR. DEAN: Object to the form of the question.

And also note you didn't read the entire answer to the question into

the record. You only chose a few select sentences.

MR. ANWAR: You can the -- correct.

THE WITNESS: Could you repeat the question?

BY MR. ANWAR:

Q. Sure.

The -- it's what we -- what we've been talking about, that the purpose of the simulated monthly estimated contaminant concentrations produced by the Tarawa Terrace model, those were intended to be used for an EPI study, right, that ATSDR was performing?

MR. DEAN: Object to the form of the question.

You've asked this same question 50,000 times already. I'm not going to instruct the witness not to answer it but --

MR. ANWAR: Kevin, I'm going to ask you to limit.

MS. HURT: -- you keep asking the same question 40 different times, and

you're looking for a specific response you're not getting. So I would --
BY MR. ANWAR:
Q. The answer is correct. It was used for an EPI study; right?
MR. DEAN: Object to the form of the question.
BY MR. ANWAR:
Q. It was intended for use for an EPI study; right?
MR. DEAN: Object to the form of the question.
THE WITNESS: I believe so.
BY MR. ANWAR:
Q. Okay. As you sit here today, as someone that has reviewed all of the reports for Tarawa Terrace, the Tarawa Terrace model, can you point me to anywhere in the ATSDR report stating that the TT model, the Tarawa Terrace model was intended to be used for exposure -- exposure determinations in individuals in the real world?
MR. DEAN: Object to the form of the question.
This witness is not qualified,

and he's told you that, as an
epidemiologist.
THE WITNESS: The answer
would be no.
BY MR. ANWAR:
Q. Okay. And can you point me to anywhere in the ATSDR reports stating that the Tarawa Terrace model was intended to be used in litigation as part of a causation analysis for individual plaintiffs?
MR. DEAN: Object to the form
of the question.
THE WITNESS: I do not recall
seeing any mention of litigation in
there.
BY MR. ANWAR:
Q. Okay.
MR. DEAN: It was an
independent study performed by the United
States government.
MR. ANWAR: I am going to hand
you what I'm marking as Exhibit 9.
(Document marked for
identification as Konikow Exhibit 9.)

BY MR. ANWAR:
Q. And if you turn to page Roman numeral III again, the Foreword. The almost identical language is included as in the Tarawa Terrace report, and I'll read it. It says:
ATSDR "is conducting epidemiological studies to evaluate the potential for health effects from exposures to volatile organic compounds (such as PCE, TCE, and benzene) in drinking (finished) water at U.S. Marine Corps Base Camp Lejeune, North Carolina. Historical exposure data needed for the epidemiological studies are limited. To obtain estimates of historical exposures, ATSDR is using water-modeling techniques and the process of historical reconstruction to quantify concentrations of particular contaminants in finished water and to compute the level and duration of human exposure to contaminated drinking water."
Did I -- did I read that correctly?
A. Yes.
Q. Okay. And again here in the Foreword, it's stating that the historical

exposure data needed for epidemiological studies; correct?

MR. DEAN: Object to the form of the question.

THE WITNESS: Can you repeat the question?

BY MR. ANWAR:

Q. It's stating here historical exposure data is needed for the epidemiological studies that ATSDR is performing; correct?

A. Yeah.

Q. Okay. And that was the purpose of the Hadnot Point/Holcomb Boulevard model; correct?

MR. DEAN: Object to the form of the question. Mischaracterizes prior testimony.

THE WITNESS: Well, my understanding is -- is the purpose of the model was to reconstruct or to estimate how concentrations of these contaminants varied in time and space.

BY MR. ANWAR:

Q. For the epidemiology -- epidemiological studies; right?

MR. DEAN: Object to the form of the question.

THE WITNESS: Well, I think that's stated here that that's the ultimate goal, but, again, the model itself doesn't know or care what the purpose of the use of the output would be.

BY MR. ANWAR:

Q. And, again, if we turn to page A182.

A. What page?

Q. A182.

MR. DEAN: A182? It only goes to A164.

MR. ANWAR: Oh, I'm sorry. I must have put the wrong one there. Sorry.

BY MR. ANWAR:

Q. Okay. We can skip that. That's fine.

And earlier you talked about the conception or earlier we discussed the sentence in your book about the importance of the conceptual model, forming the conceptual model in relation to

efficiency and accuracy of the model.

Do you recall that?

A. I do.

Q. Okay. And the conceptual model, to be clear, for both of the ATSDR models, Tarawa Terrace and Hadnot Point, was to estimate monthly contaminant concentration levels for EPI studies?

MR. DEAN: Object to the form of the question.

Last time. I'm going -- next time I'm going to instruct him not to answer your question because you've asked it now, according to my calculations, at least 110 times, and his first answer is all that you needed.

So if you don't like his answer, move on to some different subject, but this is the last time. I'm going to let him answer it, but next time I'm going to ask him to instruct him not to continue answering your questions.

BY MR. ANWAR:

Q. The answer is correct; right?

MR. DEAN: Object to the form.

THE WITNESS: Can you repeat the question?

MR. ANWAR: Okay. And your -- Kevin, I'm going to say, your objection is noted. You know as well as I do the rules with issues to objections to form in a non-suggestive manner. I'm going to ask you to limit your speaking objections. You keep making speaking --

MR. DEAN: Well, we can call the court because I can have this court reporter read me how many times you've asked that same question, and we can get the judge on the phone and ask him how many times you get to ask him that question. It's the same one.

MR. ANWAR: During -- during the next break --

MR. DEAN: Do you dispute you've asked him the same question more than 10 times?

MR. ANWAR: During the break, I'm happy to do that. Let me focus on my questioning.

BY MR. ANWAR:
Q. The question is the conceptual model -- you would agree the conceptual model, as -- as confirmed by the statements we've just read from the -- from the actual reports, the conceptual model for ATSDR's Tarawa Terrace model and Hadnot Point model was to estimate contaminant concentration levels for EPI studies; right?
MR. DEAN: Object to the form of the question.
THE WITNESS: No.
BY MR. ANWAR:
Q. What was -- what was the conceptual model then?
A. The conceptual model is your idea of how the system works, how the flow system works. Your understanding of what constitutes an aquifer versus a confining layer.
The conceptual model is relevant to how you structure the model. It's not -- it's not a description of the purpose of the model.
Q. Okay. And that's -- that's a -- I appreciate that clarification.
The conceptual model that was

developed for the purpose of the ATSDR Tarawa Terrace and Hadnot Point/Holcomb Boulevard models was developed in mind of the actual purpose for which the model was being used, which was exposure estimates for EPI study; correct?

MR. DEAN: Object to the form of the question.

I'm not sure if anybody would understand that question.

THE WITNESS: I don't know what was in their mind when they developed the conceptual model.

BY MR. ANWAR:

Q. Okay. Now, in your report, you give a couple examples of other instances where -- well, let me back up for a second.

As it relates to the Hadnot Point/Holcomb Boulevard model, can you point me to any statement in the ATSDR reports stating that that model was intended to be used for exposure determinations in individuals in the real world?

MR. DEAN: Object to the form.

THE WITNESS: I would have to reread the whole report carefully and see

if it says that. I...

BY MR. ANWAR:

Q. Having read the reports in preparation for your deposition, as you sit here today, can you -- can you -- are you aware of any such statement in the reports?

MR. DEAN: Object to the form.

THE WITNESS: Well, I believe that the Foreword that we just went over describes that the ultimate purpose is to evaluate the potential for health effects from exposure to volatile organic compounds.

BY MR. ANWAR:

Q. Okay. Can you point me to anywhere in the -- in the Hadnot Point/Holcomb Boulevard reports that states that particular model was intended to be used in litigation as part of a causation analysis for individual plaintiffs?

MR. DEAN: Object to the form --

THE WITNESS: I --

MR. DEAN: -- of the question.

THE WITNESS: I don't recall

seeing anywhere in the reports that litigation was mentioned. So I would have to say no.

BY MR. ANWAR:

Q. Okay. Now, in your rebuttal report, you identified two examples of hindcasting models; correct? Other examples of hindcasting models; correct?

A. I think I identified two models where that had been done but had never been called hindcasting.

Q. Okay.

A. And that wasn't -- that was just done as part of the modeling exercise, as part of the model output. It just wasn't the main purpose of those models, and it was just a consequence of the modeling, but in effect that's what was done.

Q. And that was the Rocky Mountain Arsenal in Colorado example; correct? One of them?

A. One of two examples was from the Rocky Mountain Arsenal, which I'm very familiar with because I had done the modeling and I had written the reports about it.

Q. And the other one is the Lawrence Livermore National Laboratory example; correct?
A. Correct.
Q. Now, the Rocky Mountain Arsenal examples wasn't about reconstruction -- reconstructing contaminant concentrations to determine exposures in individuals; right?
A. The issue of determining exposures has nothing to do with the model, in the sense that you're trying to develop a model that simulates the system based on your understanding of the physical and chemical --
THE VIDEOGRAPHER: Counsel, could please fix your mic. I'm not picking up your questioning.
BY MR. ANWAR:
Q. Earlier you mentioned that you had been deposed related to the Rocky Mountain --
A. Yeah, I'm not sure I finished answering the previous question --
Q. Okay.
A. -- because of the interruption.
But I think what I was going to add was that the assessment of health effects is

external to the development of the model. It's not in the groundwater flow and transport models. It has no impact on the groundwater flow and transport model.

You're doing the best you can to develop the models that simulates -- reproduces the historical distributions, but that model development should not be influenced by what the output might be used for.

MR. ANWAR: Okay. I am handing you what is being marked as Exhibit 10.

(Document marked for identification as Konikow Exhibit 10.)

BY MR. ANWAR:

Q. Now, this is the article that you wrote about the Rocky Mountain Arsenal study; correct?

A. Yes.

Q. Okay. And in the Rocky Mountain Arsenal study -- and actually if you want to look at your report for this, it's on page -- it's on page 3 of your rebuttal report if you want to jump back to -- to that.

A. This? Okay. Wait. The rebuttal report? Page 3? Okay.

Q. You state at the start of the second full paragraph:

Hindcasting was accomplished as a part of a study at the Rocky Mountain Arsenal. Contamination problem in which I developed and calibrated the groundwater flow and transport model. The Rocky Mountain Arsenal began operations in or about 1943. Groundwater contamination problem was recognized in 1954 and 1955."

Did I read that correctly?

A. Yes.

Q. Okay. And so to the extent that you are estimating contaminant concentrations or anything in the past, it was over that 12- or 13-year period from -- date from 1954, 1955 back to 1943; right?

A. Yeah. Well, that was the first period there was no data. There were several other periods for which there were no data.

Q. Okay. And you say there were no concentration data were available for the first 13

years of operation; correct?
A. Correct.
Q. And in Camp Lejeune for both the Hadnot Point/Holcomb Boulevard and the Tarawa -- Tarawa Terrace models, those models are attempting to reconstruct historical contaminant concentrations over a 30-year period; right?
A. Yes.
Q. Okay. From observed data in 1982, contaminant concentration level in 1982 till 1953 or earlier; correct?
A. Correct.
Q. Okay. So if we turn to the Introduction, if we turn back to Exhibit 10, which is your article on Rocky Mountain Arsenal, on page 1, there's -- on page numerical 1, there's an Introduction there; right?
A. Correct.
Q. Okay. And it says:
"The contamination of a ground-water resource is a serious problem that can have long-term economic and physical consequences that might not be easily remedied. Although the prevention of ground-water contamination provides

the most satisfactory result, the capability to predict the movement of dissolved chemicals in flowing ground water is also needed in order to (1) plan and design projects to minimize ground-water contamination."

Did I read that correctly?

A. Yes.

Q. So that -- that was one of the uses for the model; correct?

A. That's potential use of models.

Q. Okay.

A. I don't believe I was talking specifically about this model, but I was talking about models in general.

Q. Okay. Number 2. "Estimate spatial and temporal variations of chemical concentrations."

Correct?

A. Yes.

Q. Number 3. "Estimate the traveltime of a contaminant from its source to a ground-water sink (a discharge point, such as a stream, spring, or well."

Correct?

A. Yes.
Q. Number 4. "Help design an effective and efficient monitoring system."
Correct?
A. Yes.
Q. And then number 5 is "Help physical and economic feasibility of alternative reclamation plans for removing contaminants from an aquifer."
A. "Help evaluate."
Q. "Help evaluate." Thank you.
"Help evaluate physical and economic feasibility of alternative reclamation plans for removing contaminants from an aquifer and (or) preventing the contaminants from spreading."
Right?
A. Right.
Q. And those were the purposes of this model; correct?
A. Well, those -- those were listed as general purposes for groundwater models -- groundwater contamination models. I don't think those six bullet points -- five bullet points were meant to be narrowly applied to the Rocky Mountain

Arsenal. It was more of a general introduction, but yeah, that certainly would apply to the Rocky Mountain Arsenal model.

Q. If you turn to page 40 of the model.

A. 40?

Q. Excuse me. 40 of the exhibit of your study.

THE VIDEOGRAPHER: Sir, please try and be professional. It's making very muddy record.

MR. ANWAR: Okay.

BY MR. ANWAR:

Q. And so 40 there's a Summary and Conclusions; correct?

A. Yes.

Q. The Summary and Conclusions, if you go down to the third full paragraph.

A. Which paragraph?

Q. Third full paragraph.

A. Okay.

Q. "The predictive accuracy of the model is most limited by adequacy of the input data."

Did I read that correctly?

A. You did.

Q. And do you agree with that statement?

You wrote it.

A. Yeah, I think I do. Yeah. Yeah.

Q. Okay.

A. Yeah, I wrote it 50 years ago. So I'm just making sure I still agree with it.

Q. Those are the questions I have about that exhibit.

A. Okay.

Q. And so the other example you gave was for the Lawrence Livermore National Laboratory site; is that right?

A. Yes.

Q. And I think in the -- in your rebuttal report, you reference it as a study in groundwater authored by Rogers; is that right?

A. That was Rogers, who's with the Lawrence Livermore National Laboratory, or at least he was when he wrote the article.

MR. ANWAR: Okay. I'm going to go ahead and mark this as Exhibit 11.

(Document marked for

identification as Konikow Exhibit 11.)

BY MR. ANWAR:

Q. Is this the article by Rogers that you were referring to --

A. Yes.

Q. -- in your report?

A. Yes.

Q. And in the Abstract there, it states that:

"Failure to incorporate retardation factors in solute transport predictions can lead to serious miscalculations of the degree of contamination and the time required for remediation."

Did I read that correctly?

A. Yes.

Q. And do you still -- do you agree with that?

A. Well, yeah, I mean, retardation factors would certainly be considered if a particular constituent is being retarded by chemical reactions or biological reactions of any kind.

Q. And under Introduction, it says:

"A ground-water model can only be -- can be only as accurate as useful -- and useful as the degree to which the modeled flow and transport mechanisms completely represent the significant characteristics of the system."

Do you agree with that?

A. Yeah, in general. Sure. Yeah.

Q. Now, the modeling for the Lawrence Livermore National Laboratory site in California, it wasn't attempting to estimate historical contaminant concentrations for exposure determinations in individuals; right?

A. Well, for one thing, the purpose of the model and what it's used for has nothing to do with how well the model is calibrated. That's something that comes after the model. So to me that just seems irrelevant to assessing the model.

Q. But the purpose of this Lawrence Livermore National Laboratory site model wasn't to attempt historical contaminant concentration exposure levels in individuals; right?

A. The model -- the purpose of the model was to reproduce what was going on in the system. So.

Q. And what was being -- what was -- what was --

A. So as a natural consequence, this was a problem that had many analogies to Hadnot Point/Holcomb Boulevard. The contamination based on the historical understanding is believed to have started in the early 1940s, 1942 or '43, and a contamination problem was recognized decades later. And the first time for which there is any measurements of concentrations was around 1982 to '85. So I don't remember the exact year.

Q. The --

A. So to run the model to analyze what was there now -- we're in 1992 when it was done -- they had to start from that initial condition, a period of -- I don't know what -- 30 years when there was no data available and then calibrate to the later data. But part of that is your -- the model is in effect historically reconstructing the distribution during that time in which it.

So in principle, it's very similar to what was done in Tarawa Terrace.

Q. But the information that this model produced wasn't used for exposure estimates --

A. I don't --
Q. -- in individuals?
MR. DEAN: Object to the form of the question.
THE WITNESS: I have no idea what it was used for.
BY MR. ANWAR:
Q. Can you point to -- can you direct me to anywhere in the -- the article where the purpose is identified as estimating concentration levels for exposure determinations in individuals?
MR. DEAN: Object to the form.
THE WITNESS: I don't think so.
MR. ANWAR: Okay. You can set that aside.
We've been going for a little while. Now might be a good time to take a lunch break.
MR. DEAN: How long you want to take? 30 minutes?
MR. ANWAR: What do you guys think? 30? 45?
MS. SILVERSTEIN: I think 45.

MR. ANWAR: Okay. Yep.

MR. DEAN: See you back 1:30.

MR. ANWAR: Sounds good.

THE COURT REPORTER: We are going off the record. The time is 12:46 PM.

(Whereupon, at 12:46 p.m., a luncheon recess was taken.)

AFTERNOON SESSION

(1:43 p.m.)

LEONARD KONIKOW, PHD

called for continued examination and, having been previously duly sworn, was examined and testified further as follows:

EXAMINATION (CONTINUED).

THE VIDEOGRAPHER: We're back on the record. The time is 1:43 PM.

BY MR. ANWAR:

Q. Good afternoon, Dr. Konikow.

A. Good afternoon.

Q. Hope you had a good lunch. We are back on the record from a lunch break.

Are you okay to continue?

A. Yes.

Q. Okay. During your lunch break, did you discuss the substance of your testimony with your lawyers at all?

A. No.

Q. Okay. When we left off prior to the lunch break, I had asked you some questions about the Rocky Mountain Arsenal study that you had worked on.

Do you recall that?
A. Yes.
Q. I wanted to ask you. You mentioned that you sat for a deposition related to that work.
Do you recall what year that deposition took place?
A. No, I don't. It -- I looked to see if I had any records of it, and I couldn't find any. It was probably in the early to mid-'80s. It could have been earlier. It could have been a little later. I don't. I know where it was, but I don't know even what year it was.
Q. Where did the deposition take place?
A. It was in the Sheraton Hotel in Reston.
Q. Oh, in Reston out here.
A. Yeah.
Q. Okay. Thank you.
I wanted to ask you about some of the opinions in your report.
So if you want to direct your attention back to Exhibit 2, which is your rebuttal report, and I wanted to start by focusing

on page 6 of your rebuttal report, which is Opinion 1.

A. Okay.

Q. And there, you know, I don't want to read the whole thing, but there -- there you offer some opinions about in response to Dr. Spiliotopoulos, and it concludes by saying, in the third paragraph you say:

"Dr. Spiliotopoulos overstates the lack of data for the Camp Lejeune groundwater system."

Is it your opinion that Dr. Spiliotopoulos overstated the lack of historical concentration data available for ATSDR's water modeling efforts related to Camp Lejeune?

A. Well, that doesn't say concentration data. It says he overstates the lack of data. So I take that mean to all data related to the model including hydraulic data, water data, and he's implying or stating that there is a lack of data.

Q. Is it your opinion that there was a lack of historical concentration data available for ATSDR's modeling efforts at Camp Lejeune or

related to Camp Lejeune?

A. Well, as far as I know, it's factual that there was no data between 19 -- are we talking Tarawa Terrace or the other one or all of them?

Q. For concentration -- observed data for concentration levels, let's start with Tarawa Terrace and then Holcomb Boulevard?

A. Prior to 19 -- yes, there were no -- best of my knowledge, there were no concentration data available prior to 1982.

Q. Okay. And you'd agree that the concentration level data for any of the VOCs at issue at Camp Lejeune -- TCE, PCE, vinyl chloride benzene -- prior to 1982 does not exist in terms of real-world data; correct?

MR. DEAN: Objection.

THE WITNESS: In terms of what?

BY MR. ANWAR:

Q. So you'd agree that prior to 1982, concentration level data for any of the VOCs at issue at Camp Lejeune -- TCE, PCE, vinyl chloride, benzene -- it doesn't exist?

MR. DEAN: Object to the form of the question.
THE WITNESS: Well, my answer would be, I don't know for sure that it doesn't exist, but I have not seen any and I saw no reference to any.
MR. ANWAR: Okay. I'm going to mark an exhibit.
Mark this as Exhibit 12.
(Document marked for identification as Konikow Exhibit 12.)
BY MR. ANWAR:
Q. This is -- so this is Volume II of the transcript from the 2005 ATSDR expert panel.
Would you agree with that?
A. Yes.
Q. Okay. And on the front of the -- the front of the transcript, it states that the meeting review -- meeting peer review panel was held at Century Boulevard in Atlanta, Georgia on Tuesday, March 29, 2005.
Do you see that?
A. Yes.
Q. Okay. And is that consistent with

your understanding about when the peer --
A. Well, I don't remember the address, but, you know, that seems to be when the meeting was held.
Q. Okay. And you don't have any reason to disagree with that; right?
A. No.
Q. Okay. Now, when you -- when you participated in both the 2005 and the 2009 expert peer review panels, were you aware that the conversations were being transcribed?
A. I probably was.
Q. Were you aware that these transcripts now exist?
A. Yes.
Q. And is it fair to assume that whatever discussion that took place both in 2000 -- at the 2005 expert panel and the 2009 expert panel, those were your -- your honest thoughts at that time?
A. I would think so.
Q. Okay. You wouldn't have any reason to attend an expert peer review panel and lie or make anything up; right?

A. Absolutely not.
Q. Okay. So I wanted to have you turn to page 47, and then at the bottom of 47 line 25 it starts by saying -- and then it will go on to page 48:
"DR. KONIKOW: Well, you have very limited data against which to calibrate your model. Okay. And you know, in the period that you were collecting data, the wells were contaminated. Okay. So if you're going to run the groundwater model, it's a question of how do you get from zero to that level of concentration that you're calibrating. You start with an initial condition of no PCE in 1954. Okay."
Did I read that paragraph correctly?
A. You read it correctly, yeah.
Q. Okay. And when you said, "Well, you have very limited data against which to calibrate your model," those -- those were your words; correct?
A. Apparently.
Q. Okay. And do you have any reason to disagree with those -- those words?
MR. DEAN: Object to the form

of the question.

And you're also providing him -- not providing the context in which the -- his comments are for the several pages before that.

BY MR. ANWAR:

Q. Do you have any reason to disagree with what you said?

A. (Reviews document.)

Well, yeah, they were talking about the calibration. No, I don't disagree with it.

Q. And it says "You start with an initial condition of no PCE in 1954" --

A. Yeah, that --

Q. -- we're talking about Tarawa Terrace; right?

A. Yeah. Maybe that should have been '53. I don't remember the time.

Q. And then the next paragraph you state:

"And then you start your model running. And there's going to be speculation upon assumption built into that, and you'll get a range of responses. My hypothesis or my guess would be

that all roads will lead to contamination by 1968. You may want to do the modeling to demonstrate it. Maybe I'm wrong."

Did I read that correctly?

A. You read it correctly.

Q. And you said "there's going to be speculation upon assumption built into that"; right?

A. That's what it says.

Q. What did you mean by "speculation upon assumption built into that"?

A. Well, I assume that I was talking about the boundary conditions and other assumptions built into the model. In other words, get the model run, it has to have specific numbers for where fluid comes into the system, where it leaves the system, where solute mass is added to the system and so on.

And for the period where there was, you know, no record, you know, that those estimates have to be reconstructed from the best data available.

So for recharge to the aquifer, you look at precipitation records and maybe the

estimates of soil properties that you could, and you make a reasonable estimate of recharge but, you know, it's not an observation.

And, you know, the same with the mass loading. You know, for Tarawa Terrace, they knew where the source was, but, you know, there was no one recording the people dumping the PCE. So you had to make an assumption or approximation about an average rate, and even with an average rate, you don't know the specific rates.

It may have been higher one week and lower the next week, and there's no way to get that variability. So you would do your best to estimate long-term average rates.

Q. Got it.

And in that second paragraph, you go on to state:

"My hypothesis or my guess would be that all roads will lead to contamination by 1968."

Right?

A. That's what it says, yes.

Q. Okay. And when you said 1968, you're referring to 1968 as the start of the

epidemiological study that ATSDR was wanting to perform; right?

A. I presume so. Again, this was 20 years ago. I don't remember exactly what my thoughts were.

Q. And you go on in the third paragraph to say:

"But you want -- the only possible outcome that would differ would be a later arrival, and that may be the first few years there's no exposure. I think that's unlikely, but that's what you want to evaluate, and that's probably best -- the best you could hope from -- from all of these models."

Did I read that correctly?

A. You read it correctly.

Q. Okay. When I -- when I read this section of the transcript, it -- it appears to me that the question that you're addressing is whether -- in terms of mass loading whether PCE would have contaminated the aquifers by the start of the EPI study.

Is that -- is my understanding correct?

A. Well, that's my under --

MR. DEAN: Object to form.

THE WITNESS: I'm sorry. Did you?

MR. DEAN: I just -- objection.

THE WITNESS: Okay. My, you know, understanding at the time and from the preliminary documents I read this, I thought as a reviewer my obligation was to question pretty much everything about the groundwater flow and transport models.

I don't think I really thought that there would be an arrival later than 1968. I was just giving them a probing question.

BY MR. ANWAR:

Q. Okay. Do you know for a fact -- well, let me -- let me back up.

When you say in the third paragraph, "the only possible outcome that would differ would be a later arrival, and that may be the first few years there's no exposure," you're acknowledging

there the possibility that the PCE -- that Tarawa Terrace was not contaminated on day one in 1953; right?
A. On day one?
Q. Yeah.
A. I don't know that that's acknowledging it, but I think it -- the first day it's probably not contaminated. It takes time. If they're dumping this in a drain or on the land surface, it takes time to get down to the aquifer.
Q. Contaminants, you know, if you're pumping PCE onto a land surface, it doesn't immediately go into the aquifer; correct?
A. Correct.
Q. It needs to travel through the subsurface; correct?
A. Through the unsaturated zone.
Q. Okay. Of the subsurface; correct?
A. Yes.
Q. Do you have any understanding of how -- how long it takes for PCE to travel generally or -- let's start generally.
A. You know --
MS. BAUGHMAN: Objection.

THE WITNESS: -- it's hard to
generalize, but it depends on the
individual circumstances.
BY MR. ANWAR:
Q. Was -- did any discussion take place in the context of Camp Lejeune at the expert peer panel -- peer review panel about how long it would take PCE to travel from the ground through -- through the subsurface into the aquifer?
A. I don't recollect that, but I would expect that the issue was mentioned and discussed somewhere. But I don't recall it.
Q. And in your -- in the transcript here, you're saying it could be a few years later after ABC Cleaners started operating; right?
A. No, I don't think that's the case.
Whatever is said there, I thought that was an extremely unlikely but, theoretically possible, outcome. But, no, I thought from the time they started dumping it, you're talking about days to weeks before it reaches the water table, at most a month or two.
I mean, because you're talking about disposable of a dense nonaqueous base liquid.

That substance is going to sink pretty fairly -- pretty quickly towards the water table. Some of it getting dissolved on the way down and, you know, we're talking mostly about how it's moving in solution, not as a dense separate phase.

Q. Okay. We'll return to mass loading.

If you could turn to -- I think your might already there, but I'm looking at page 49 line 14 through 19.

And it starts "DR. KONIKOW."

Are you with me?

A. Yes.

Q. Okay.

"DR. KONIKOW: But I'm guessing the outcome is still going to be, from the start of your epidemiological study to the end, Tarawa Terrace residents were exposed, which, if you could support that, it kind of mediates the need for more refined modeling because it's not going to yield anything more."

Did I read that correctly?

A. You read it correctly.

Q. And here in -- in the 2005 expert peer review panel, the focus of the discussion

appears to be what you need for the -- the type of information you need for the ATSDR epidemiology -- epidemiological study that was -- was going to be performed; right?

A. Well, I think the focus was on the development of the transport model to compute the concentrations needed for that, but I think the focus of the modeling of our discussions that I was commenting on was not the epidemiological studies or the exposure. It was on the transport model. You know, there were comments about the epidemiological study, but that only in the sense of that that's what the results were going to be used for.

Q. So, and if we read it again:

"But I'm guessing the outcome is still going to be, from the start of your epidemiological study to the end, Tarawa Terrace residents were exposed, which, if you could support that, it kind of mediates the need for more refined modeling because it's going to yield -- it's not going to yield anything more."

Those are your words --

A. Yes.

Q. -- correct?
A. Yes.
Q. And when you say, "if you could support exposure at the start of the EPI study, it kind of mediates the need for more refined modeling because it's not going to yield anything more than that," what did you mean?
A. I'm not sure. Looking at this, I'm not sure what I meant by "more refined modeling." Yeah, I'm not sure. I don't remember.
But -- yeah. I don't know. You know, I didn't read carefully the several pages before this to look for context of that comment.
Q. Okay. But you're not denying that -- when you say -- scratch. Strike that.
When you say "because it's not going to yield anything more than that," what did you mean?
A. I assume that it meant it would yield the concentration distributed over time and from that the concentration in the water supply wells and that's -- that's what you'd expect from it.
Q. Okay.

A. Certainly these models were not going to assess human health effects from these models themselves. That's a totally other different thing that has to be used. But these models provide the input to that type of assessment.

Q. I will say, aren't you saying here -- so as an outside observer or someone who didn't participate in this panel, what it looks like you're saying here is that the best that the TT model -- the Tarawa Terrace modeling can do is determine whether the population at Tarawa Terrace would have been exposed or not?

MR. DEAN: Object to the form of the question.

THE WITNESS: No, that's not what I --

BY MR. ANWAR:

Q. Because you say --

A. -- meant.

Q. -- "it's not going to yield anything more than that"?

A. I meant the concentration at the location of the water supply wells is I think what

I was referring to. By, you know, "more refined modeling," perhaps I meant with a finer grid or a finer time step or something, but, again, I don't recall exactly what I meant by that term.

Q. Okay. So it's your testimony today that you have no recollection of what your words here mean?

A. Well, I wouldn't say that.

The specific term "more refined modeling," I don't recall what I was thinking at that point, but the general gist there I think is still clear and I would agree with.

Q. If you were asked to describe a more refined model in present day terms, how does a more refined model compare to a simpler model?

A. Well, a more refined model could be solving the same governing equations but do it over a much finer grid with a much better definition of hydraulic properties.

Hydraulic properties is something you don't have to go back in time to get because they remain constant in time. So you could drill more wells, get more pumping tests, get a better definition, maybe use a new geophysical method,

get a better definition of the porosity distribution, and that would be a more refined model with possibly smaller grid spacing and better definition of hydraulic parameters.

A more refined model might be one that includes more processes that weren't included in the transport model. I'm not sure what exactly that would be, but maybe instead of using a retardation factor, it tried to represent the actual chemical and biogeochemical processes more accurately than the simplified approximation of using the retardation factor.

So you could have a more refined model in terms of the processes that affect the concentration as it's being transported, but, you know, the use of a retardation factor is a common, standard way of simplifying all the reaction terms.

Q. When -- when you start developing a new model, do you start with a more refined model or do you start with a simpler model and then build towards a more refined model?

A. Well, we try to start as, you know, after we build the conceptual model of what's

going on, we'll try to build as simple as possible and see if we need to, you know, refine the grid spacing, add more processes, anything like that.

So yeah, general rule is, you know, you develop a conceptual model about what the governing processes are, what needs to be considered, and then you develop a model.

You discretize it at some grid spacing that seems reasonable based on your judgment and experience, and you assess whether or not that's adequate one way or another, usually through numerical experiments. And if it's not, use a finer grid, and if it's adequate, you either stick with it or maybe even based on computational efforts you might decide to use a coarser grid to reduce the computational time.

Q. Does the term -- and I may -- may mispronounce this, but does the term "parsimony" mean anything to you?

A. Parsimony.

Q. Parsimony?

A. Yeah. It's basically a fancy way of talking about the simplicity or complexity of the model. Parsimony implies you use the simplest

possible approach. You want a parsimonious model.

Q. Okay. Why is that?

A. Well, the more complex a model is, the harder it is for the modeler and the analyst to understand what the model is doing. And you want to -- it's obviously better if you understand what the model does. The simpler the model is, the more you can understand what is going on in the model mathematically.

If you have a multitude of reaction terms and transport terms and all in the same model and something unexpected happens or something showing up, you're not sure exactly why that's happening. There's too many things to do, to look at.

So, you know, you always want to use the simplest possible model, but the difficulty is always assessing how do you know that it's not too simple. And there's judgment calls in there and discussions with colleagues and so back and forth.

It's not just a perfectly objective type of assessment. You need some judgment calls and decisions as to what level of complexity to build in. It's not necessarily that one is wrong

or one is better, but sometimes there's, you know, in modeling, particularly in the older days, there was always a trade-off with computer resources because you were much more limited 20, 30 years ago in terms of computer capabilities than you are today. So that always factored into it in terms of efficiency versus, let's say, complexity and accuracy.

Q. Okay. In terms of adding complexity to a model, are there circumstances under which adding complexity to a model could increase the uncertainty or decrease the accuracy of the model?

A. I suppose. I mean, if you add more and more processes, then you're going to require more and more parameters that need to be defined. And if you don't have good ways to measure those parameters, then you're in effect adding more uncertainty even though you're representing more processes.

So it's not always a good thing to do, and, again, it may mask what's really happening in terms of what's causing things to happen.

Q. Okay. Thank you.

On page 7 of your rebuttal report, Exhibit 2. I'm going to be jumping --
A. What page?
Q. It's --
A. 7?
Q. I'm going to be jumping back and forth between your rebuttal report and probably the transcript. So it might be good to have both side by side or -- or I can tell you. Let me do it this way.
There is a reference in your report, it's in Opinion 2, where you mention that Dr. Spiliotopoulos -- Spiliotopoulos says that the results are conservative. You said:
"Dr. Spiliotopoulos says this results in conservative estimates of estimated monthly contaminant concentrations. It is not clear what is meant by 'conservative' or why that is not a good trait. He also says the results are biased high."
If you'd like to read it, it's in Opinion 2 page 7.
But do you recall that portion of your opinion?

A. Yeah, I'm looking at it now. Yes.
Q. Okay. And so if you go back to the transcript that we were just looking at, the 2005 transcript.
A. Yeah.
Q. On page 49. You question in your report:
"It is not clear what is meant by 'conservative' or why that is not a good trait."
And right after 14 and 19, the discussion we were just having about your comments, Mr. Maslia responds:
"Then from the standpoint of being conservative from a public health standpoint, let's assume we refine our groundwater understanding and we get" -- and then he goes on.
When we're talking about -- sort of as reflected in Mr. Maslia's statement there, when we're talking about conservative in terms of ATSDR's Camp Lejeune modeling, we're talking about from a public health standpoint; right?
MR. DEAN: Object to form.
THE WITNESS: I -- I don't recall what he was talking about, but he

says "from a public health standpoint."
BY MR. ANWAR:
Q. What does "conservative" mean to you from a public health standpoint?
A. To me that implies being very careful and safe on what you're doing and not going beyond the basis of the data and supporting modeling studies. You know, it could mean other things.
Q. Would you agree that conservative from a public health standpoint could mean being health protective?
MR. DEAN: Object to the form.
THE WITNESS: I'm -- yeah, you know, I'm not a health expert or an epidemiologist. So I'm not sure what common usage of that means, but that sounds okay.
BY MR. ANWAR:
Q. Because, I mean, we've discussed this.
The modeling was being used for -- to produce information for an EPI study; right?
MR. DEAN: Object to form of

the question.

THE WITNESS: Yeah.

MR. DEAN: You asked 122.

BY MR. ANWAR:

Q. Okay. And from a public health or safety standpoint, wouldn't you err on the side of making assumptions and using inputs that you consider sort of results of exposure that's at greater risk to the public?

A. I guess I think I need a more specific example, but maybe repeat the question.

Q. So, for instance --

A. Yeah.

Q. -- we were talking about mass loading a moment ago; right?

A. Yeah.

Q. And there was a question whether mass loading started on -- for Tarawa Terrace whether it started in 1953, the day that ABC Cleaners opened; correct?

A. Yeah.

Q. Okay. And I think at least in the passage that we discussed, there was a discussion about whether or not the mass could have

traveled -- it would have taken a couple years for the mass to travel through the aquifer so that --

A. To where?

Q. In Tarawa Terrace. The mass. We're talking about the Tarawa Terrace model.

A. To travel from where to where?

Q. From the dumping on the ground from the dry cleaner to the subsurface into the aquifer.

A. No, we did not say.

I said that it would probably take days to weeks, maybe a month or two. That's what I would -- that I would estimate was the travel time from disposal by the dry cleaners into the land surface until it reaches the water table, which I would think was on the order of 20 feet below the land surface.

Q. Okay. Let's -- let's take what you're saying out. We'll return to your statements.

But let's say, for instance, the question was whether you decide the concentration started mass loading immediately into the aquifer in 1953 or 1960.

And if you were deciding between those two start dates, from a public health standpoint, isn't it more health protective to assume -- to assume more people were exposed than less to protect those people?

MR. DEAN: Object to form.

THE WITNESS: I'm not qualified to answer that.

But what I will say, from the perspective of the model, being protective of public health really should not enter into your assessment of mass loading, hydraulic properties, or anything else related to the model should not be influenced by any perception of health effects. That would not be sound application of groundwater modeling.

BY MR. ANWAR:

Q. And are you saying that -- well, why not?

A. The development of a groundwater model should be based on your understanding of the hydrogeologic framework of the boundary conditions. Mass loading is one type of boundary

condition, and it should be based on hydrogeological and hydrochemical evidence.

You know, basically I don't see why you would, you know, in developing, doing your best scientific engineering efforts to develop a sound model, a reliable model, what you put into that data set of input parameters, or input data sets, should reflect your understanding of the aquifer system and the stresses on it.

And it should not -- that by itself should not be influenced by what you think the outcome might be or how you might protect human health. Protection of human health is not a component of groundwater modeling.

Q. Are you saying that ATSDR, as a public health agency and performing this -- this modeling related to Camp Lejeune, didn't account for protecting human health?

MR. DEAN: Object to the form of the question.

THE WITNESS: In my mind and in my recollection of everything that was described, there was an impartial scientific objective assessment to get

the best estimates of the input parameters, and I could -- I did not see any evidence that the selection of parameters, boundary conditions, initial conditions were influenced by ATSDR's health mandates.

BY MR. ANWAR:

Q. Why would a public health agency perform groundwater modeling for estimating contaminant concentrations without considering its mission to protect public health?

MR. DEAN: Object to the form of the question.

THE WITNESS: I would hope that they would want to get the best possible scientific estimate of how those contaminants move through the ground.

The estimate of the truth -- and, again, it's clearly estimating what had happened historically -- is what needs to be known.

They don't need to know an estimate that would be protective of human health. They need an estimate of

what actually happened.

BY MR. ANWAR:

Q. Okay. Based on this conversation that we've been having, are there any parameters that you would consider undesirable? Let's start generally.

A. Undesirable with respect to what?

Q. Well, let me strike that.

Are there any parameters that in evaluating ATSDR's water models that you determined to be undesirable?

A. Again, I'm not sure what you mean by "an undesirable parameter."

I mean, there are parameters in the model which basically reflect coefficients in the governing equations. They're all there because it's believed they're part of the governing processes. So a characteristic of desirability just is inappropriate and irrelevant.

Q. Now, I want to turn back to the opinion or critique you offered of Dr. Spiliotopoulos in terms of overstating the lack of historical concentration data available.

Could you please turn to page 193 of

the transcript that you're looking at.

A. This is from the 2005? Volume II from 2005?

Q. Correct.

A. Repeat the page.

Q. 193.

A. 193?

Q. Correct.

A. Okay.

Q. And in the middle of the page starting at line 11, you're sort of concluding -- it's towards of the panel. You can see the transcript. It's towards the end of the transcript.

"DR. KONIKOW: Well, again, I second all the comments that have been made up to now. I again just reiterate what the groundwater modeling and the transport modeling that ultimately we're limited in what we can do in terms of the available data. I mean, you know, we don't have concentration data before 1980 or '82, and so everything we do for looking at distribution before then is going to be a little fuzzy."

Did I read that correctly?

A. Yes.
Q. And those are your words; right?
A. Yes.
Q. What did you mean by "and so everything we're going we do" -- so -- strike that.
What did you mean by "and so everything we do for looking for at distribution before then is going to be a little fuzzy"?
A. Talking about before 1982 or so, the period in there. That the modeling -- when I say a little fuzzy, but what that means is you're going to make some prediction, decide, you know, your best calibration, your best fit.
But you have to recognize that there's confidence limits about that and there may be a band of uncertainty and that you have to, you know, assess that and consider that and, you know, not take the one prediction of mean as the gospel, but you have to consider -- and this is some of the things that ATSDR did.
They present many graphs with a band about their best fit calibration, and this is a way to reflect -- well, I use the term "a little

fuzzy," which is not really a scientific term but, you know, it recognizes that you have to -- that there's uncertainty in the estimate. There's uncertainty in the results. Your best fit model gives you, you know, a precise estimate, but you have to recognize that it could be above it or below it.

Q. And --

A. And I think that's kind of the consideration of that was followed with good practices by ATSDR and presented their results clearly showing, well, in that term "fuzziness" but they really showed a band about the estimate for different sources of uncertainty.

Q. And there's uncertainty in the results prior to '82 because, as you say there, "we don't have concentration data before 1980 or '82"; right?

MR. DEAN: Object to the form of the question. I'm not sure what the question was.

BY MR. ANWAR:

Q. Correct?

A. We have a very, I believe, high

confidence at the start of the period that there was initial conditions and initial concentrations that were, zero and then we have no data until about 1982 or so, and so that's what the model was used to reconstruct how that might be.

And the model basically is saying that there are certain processes we know govern the fate and transport of dissolved constituents and the movement of groundwater, and the way we make our estimation or calculation of the concentration there, we do it in a way that is consistent with everything we know about the physics.

Q. You just described uncertainty, and I just want to confirm.

That uncertainty exists because there isn't concentration data before 1982?

A. It exists for more reasons than that. It exists because the uncertainty in the definition of the hydraulic conductivity. There's some uncertainty in porosity. There's some uncertainty -- well, every parameter there's some uncertainty. Nothing is known exactly.

The KDs and RFs, the retardation

factor, these are all engineering approximations for the processes that in reality are much more complex. They're not a true and precise representation of all the processes that that causes.

It's an engineering process that -- approximation that is very common in modeling and very well accepted and it's almost, you know, it's there because it's a necessity. It helps keep the model as simple as possible. It keeps you towards parsimony, but we know it's an approximation.

The real processes that control retardation are probably nonlinear, they're not instantaneous, and they vary in space and they could vary in time. If you look at a retardation factor or a KD for one constituent, it may actually depend and vary depending on the concentration of a different constituent.

And, you know, all these -- none of those complexities are incorporated into the RF or into a KD. So they're simple -- simplifying approximations, and that's what we do in effect to some degree or another with everything in the

model.

MR. ANWAR: Understood. Thank you.

Give me one second. I'm going to grab a document.

Let's go off the record for one second.

THE VIDEOGRAPHER: We're going off the record. Time is 2:28.

(A recess was taken.)

THE VIDEOGRAPHER: We're back on the record. The time is 2:45 PM.

BY MR. ANWAR:

Q. We're back on the record after a very short break.

Thank you for bearing with me, Dr. Konikow.

I am handing you -- well, are you okay to continue?

A. Yes.

Q. And did you speak about the substance of your testimony with your --

A. No.

Q. Okay. With your lawyers during the

break?

A. With what?

Q. With your lawyers during the break?

A. No.

MR. ANWAR: Okay handing you what's being marked as Exhibit 13.

(Document marked for identification as Konikow Exhibit 13.)

BY MR. ANWAR:

Q. And sort of still on the topic of Dr. Spiliotopoulos's -- well, still on the topic of your criticism about Dr. Spiliotopoulos's -- Spiliotopoulos's statement on the lack of historical data, I've handed you the expert panel summary from 2009.

Would you agree with that?

A. Yes.

Q. Okay. The title on the document is "Expert Panel Assessing ATSDR's Methods and Analyses for Historical Reconstruction of Groundwater Resources and Distribution of Drinking Water at Hadnot Point, Holcomb Boulevard, and Vicinity, U.S. Marine Corps Base Camp Lejeune, North Carolina."

Did I read that correctly?

A. Yes.

Q. And the date of the expert panel is identified -- the 2009 panel as April 29 to 30, 2009; correct?

A. Yes.

Q. Okay. So I'd like you to turn to page 99.

Page 99 is labeled "Appendix E" to this, the expert panel summary that I just handled -- handled -- handed you.

Do you see that there?

A. Yeah.

Q. Okay. And it -- I'll represent to you that it appears to be comments submitted by you. I'm not sure if it was before or after the expert panel.

Do you recognize this document?

A. My recollection is that these were questions submitted before the panel before we met.

Q. Okay.

A. And the answers were prepared before we met, not with all the information given at the

panel.

Q. Okay. And so I wanted to turn your attention to the middle of the page -- page starting "CHARGE TO PANEL" in all bold.

Do you see that there?

A. "CHARGE TO PANEL"? Yes.

Q. Okay. And the question is: "Do the data analysis and computational methods provide an adequate level of accuracy and precision?"

Correct?

A. Yes.

Q. Okay. And your comment there states:

"The approach taken appears to be quite reasonable, as far as can be told from the available information and with exceptions noted or discussed below, but indeed the level of accuracy and precision may still not be adequate because of the paucity of data and complexity of contaminant sources during the time period when the history is to be reconstructed."

Did I read that correctly?

A. Yes.

Q. Okay. And then you go on to say:

"The adequacy will depend in large part on the reliability and soundness of the groundwater flow and transport models that will be developed (but which have not been adequately described in the reviewed documents). As noted in comments below, the approach used to estimate reaction rates appears to lack a firm theoretical basis for providing confidence in the accuracy and precision of calculated values."

Did I read that correctly?

A. You read it correctly.

Q. Okay. And these are your words; correct?

A. Apparently.

Q. And you said you submitted this before -- these -- these comments before the panel -- expert panel in 2009?

A. Before we met, yes.

Q. Okay. And they were specifically in response to questions that were issued before you met for the 2009 panel?

A. As I recall, before we met, they sent us a short list of -- I don't remember -- four, five, six questions that they requested we

answer as best we could based on the knowledge we had. And I think they had sent us some documents to review ahead of time, but it was not a comprehensive presentation of everything done at the site.

Q. Do you recall what documents they sent you to review ahead of time?

A. I do not.

Q. This summary report was published after the expert panel had taken place, though; right?

A. Yes.

Q. Okay. And your comments were attached as an appendix; correct?

A. Apparently, yes.

Q. Okay. And so in that first sentence, you say:

"But indeed the level of accuracy and precision may still not be adequate because of the paucity of data and complexity of contaminant sources during the time period when the history is to be reconstructed."

When you say "the level of accuracy and precision may still not be adequate because of

the paucity of data," what do you mean by "paucity of data"?

A. I think -- and, again, this is from 15 years ago. I think I was referring to the source terms and the lack of observed concentration values in the, you know, 30-year period or so.

But the source term, you know, is an obvious, important characteristic for the model or probably for the model parameter. And it was clear that for the Hadnot Point/Holcomb Boulevard area, there were many more sources -- potential sources of contamination than there were for the previous Tarawa Terrace -- Tarawa Terrace models.

And I thought that added more complexity and uncertainty to the -- what would be the overall model results.

Q. Do you recall how many sources there were for Hadnot Point/Holcomb Boulevard?

A. I thought there were tens of potential sources, dozens of sources, individually numerous storage tanks, industrial areas where things were going on, different buildings had different activities. There were just a multitude

of potential sources.

Q. The last sentence in that paragraph:

"As noted in comments below, the approach used to estimate reaction rates appears to lack a firm theoretical basis for providing confidence in the accuracy and precision of the calculated values."

What did you mean by that?

A. I don't recall. I assume the "reaction rates" is referring to either absorption reactions and/or the degradation term. I don't recall what exactly I meant there.

Q. If you turn the page to page 100, there is a second question there that starts with an ellipses "reconstructing historical contaminant concentrations."

Do you see that there?

A. Number 2?

Q. Yes.

A. I see it.

Q. Okay. And 2a there states "anticipated data analysis and model modeling complexities?"

That was the question; right?

A. I guess, yeah.

Q. And your response there:

"Overall, the task at hand is an enormously difficult and challenging one, and there are numerous difficulties confronting a successful completion. There are numerous sources of uncertainty both in the data analysis and the modeling results. Attempts should be made throughout the course of the project to quantify, as well possible, the degree of uncertainty in each stage of the work. In the transport modeling, the issue of estimating the appropriate magnitude of the dis --

A. Dispersivity.

Q. -- dispersivity -- thank you -- coefficients is a difficult one for which there is no simple answer or standard. This will certainly be clouded by the use of the finite-difference solution method in the MT3D transport model, and the effects of numerical dispersion on calculated early arrivals and breakthroughs, as well as on peak concentrations, must be carefully considered and evaluated, and alternative solution methods and discretizations considered."

Did I read that correctly?
A. You did.
Q. Can you elaborate a little bit here on what you meant by "the task at hand is an enormous -- enormously difficult and challenging one, and there are numerous difficulties confronting a successful completion"?
A. Well, you know, I think in any groundwater model, flow model or transport model, that's ever been developed, they face an enormously difficult challenge in representing the hydrogeologic framework in a mathematical way, as well as defining all the stresses on the system and so on.
In that sense, all the problems I faced here are problems that every groundwater model ever made over real system faces the same challenges. The degree of data available just varies.
I emphasize again that my answers to these questions were done before we had any presentation by the technical people at ASTDR -- ATSDR on what they actually did.
We had some preliminary draft

documents, which I don't recall what they were, but these answers that are prepared were prior to receiving any feedback or any answers on the questions.

So I had questions, but this was before I got any answers, but these are all issues that every modeler -- groundwater modeler always faces.

You know, here, particularly at the Hadnot Point, there was, you know, probably a more complex set of source terms than in many studies, not in all studies but in many problems.

Any specific comment you want me to address in a little more detail?

Q. Sure.

Before I ask you about specific comments you made, I think you stated that every groundwater model faces sort of these challenge.

Does every groundwater model estimate contaminant concentrations that are now used -- that are now being attempted to be used to determine exposure on individuals?

A. I doubt it but, you know, again, that end use of the modeling results really should

not influence the development of the model to any degree. The model -- the people who develop groundwater models are going to look at the hydrogeologic framer, the stressors, all the parameters in the model and do the best possible job they can to define the input data.

And the definitions of the input data for the model should not be affected by what they perceive as the ultimate use of the model, and many descriptions of groundwater models in the literature describe the groundwater model, the reliability, sensitivity, all of those things, but they very often do not describe what the model results may have been used for by other people.

Q. I understand that you're saying now that the -- the model results really -- and you should correct me if I'm misunderstanding your testimony.

What the model results are used for are really not relevant to performing the model; is that right?

A. They're all -- they're only relevant to the extent that you want to make sure the model will yield results that are relevant to the people

paying for the model development.

In other words, if you know they're going to use it for health studies based on what you predict in the -- the concentration history in water supply wells, if that's, you know, what it will be used for, then you want to, you know, kind of make sure anything related to that gets special emphasis in being as reliably estimated as possible.

So it's just a very general sense that that would have feedback into the model but, you know, in general, the standard of practice in developing a groundwater model anywhere is you make your best effort at every parameter that goes into it.

But where it might influence, well, if you know this, then you might say, we have to drill a couple more wells or we have to invest more money and, you know, that kind of feedback that you would do to do a better study.

But if you don't have that opportunity to, you know, spend another five years drilling test wells and so on, you do the best you could and that's the standard. Do the best you

could based on your understanding and knowledge of the principles, the governing equation, and the mathematics.

Q. Okay. And the reason I was asking that was because sort of going back to the section Chapter 20 of your -- your book chapter, in the section discussing model design development and application, the first sentence of that section is:

"The first step in model design and application is to define the nature of the problem and purpose of the model."

Isn't that right?

A. That's what I said. I still think that's reasonable.

Q. So when you're designing a model, isn't it unreasonable to -- to divorce how the results of the model will be used from the developing the actual model itself?

A. Well, you don't want -- you don't want to divorce it in the sense of being totally ignorant of what it is. Because that may affect -- if you know the model will be used and the results will rely on your estimates of

concentration in a water supply well, you're going to design your grid, your spatial discretization grid for the model to make sure it's fine enough around those observation -- around those water supply wells to feel that you will get a reasonably accurate result in those water supply wells.

Whereas, if your purpose is to look at regional flow and what might get into the river at the end, you wouldn't worry so much about having to find enough grid around the supply wells. You'd be okay instead of 50 feet okay 200 feet, you know, things like that.

So in the sense of being aware of the use of it, you want to know what the ultimate -- the end users need and what they're going to need, and that certainly can affect how you design the model.

It should not influence your selection of parameter values. It should not influence your selection of boundary, but it might influence your grid space and your time step. You know, if -- if the end user only is interested in how things change on a yearly basis, well, then

you use annual time steps. If they're interested in a monthly basis, you might use monthly time steps. So in that sense, it affects how you design the model.

Q. Understood.

So turning to -- back to the 2009 expert summary comments, your comments, 2b there says:

"Which modeling methods do panel members recommended ATSDR use for reliable monthly mean concentration results for exposure calculations?"

Your comments are:

"The proposed modeling methods appear to be quite reasonable and appropriate to the task, although given the complexity and the uncertainty in the underlying database, there is no guarantee about the accuracy and reliability of the results; those will need to be assessed as the work progresses. Within the broad framework of using MODFLOW and MT3D, details of the approach and implementation must be carefully evaluated, and alternatives considered, to assure the maximum chance of achieving reliable results."

Did I read that correctly?

A. You did.

Q. Okay. And what did you mean there by, although in the first sentence, "The proposed method -- the proposed modeling methods appear to be quite reasonable and appropriate to the task," and then you go on, "although given the complexity and uncertainty in the underlying database, there is no guarantee about the accuracy and reliability of the results"?

What did you mean by "the complexity and the uncertainty in the underlying database"?

A. Well, I mean, I think we've said this several times already that there's a period in which there were no observations of concentration over a period of a number of years until the early '80s.

The hydrogeologic framework everywhere always has uncertainty in it for every case, not just Camp Lejeune.

There's multiple sources, you know, it's a complex subsurface environment. For the Hadnot Point, you had very complex source terms, at least in the sense that they were in many

areas, and there were no direct observations that I recall of what leaked when. They had to make assumptions.

And I was just, you know, again, this is before we had the presentations, and I was cautioning, you know, be careful, be as accurate as possible, evaluate the uncertainty and, you know, consider alternative approaches and alternative considerations.

It was just these are just, you know, good general warnings and guidelines for any important modeling project, and, you know, this was before I heard what they did or saw their end results.

Q. Okay. So is it your testimony that your -- so we've looked at a number of statements from the 2005 transcript, as well as now the 2009 expert panel summary document where you raised -- you pointed to the lack of historical data and questioned -- raised questions about uncertainty and whether accuracy could be obtained.

And you've noted that this was before you actually sat through the 2009 expert panel.

Do you no longer hold the concerns that are reflected in all, you know, in your own words in the transcripts and in the summary documents?

A. Some of my concerns -- all my concerns, I mean, these, all the issues that were brought up were responded to. I had concerns about numerical dispersion because in the MT3D model they used a central finite-difference scheme to solve the governing equations.

The reason for doing this is that that's much more numerically efficient computer. The simulations will take less real time with the finite-difference method than with the TVD method, and so I cautioned them to assess alternatives and be aware of the numerical dispersion as a possibility.

And I saw in the later reports that they followed up on that, and they did testing and they compared it with a method of characteristics model and with a TVD model. And these refer to just the specific numerical methods used to solve the solute transport equation. That's a governing equation. There's nothing different in the

equation.

So just alternative numerical methods that were available at that time, and they -- they, I guess, took my advice and they made assessments. And I looked at the results, you know, later on or recently reviewing the documents, and I was very impressed at how little difference it made.

Everything I saw. So. Oh, sorry. Okay. I was drifting off the record.

Q. Okay.

A. Everything I saw showed that there was negligible effect of the solution method, indicating that numerical dispersion was not a problem.

Q. When you say after sitting through the expert panel and when you looked at the final product again that they addressed your concerns.

When did you look at the final reports again?

A. The final reports were -- I don't know -- sometime after 2013, whenever they were published, but I, you know, I looked at them again in the last month or two. I don't remember

exactly when I first saw the final products.

Q. So you looked at -- you looked at the reports again after you had been retained as a litigation expert; correct?

MR. DEAN: Objection to the form.

THE WITNESS: You mean recently I've --

BY MR. ANWAR:

Q. Correct.

A. Yes, I -- I looked at every one of the reports for both Tarawa Terrace and Hadnot Point. I read -- reread some of them in more detail and more slowly and some of them in less detail less slowly, but I did go every one of them.

Q. Is there any document or anything that you can point to reflecting that your concerns that you raised at the expert panels and that's reflected in the summary -- the summary report, is there any document you can point to prior to your retention as an expert reflecting that the concerns had been addressed?

A. Yeah. I think the content is in the

reports, that they did tests for grid spacing to look at the possible effects of oscillations and numerical dispersion in the solution. They -- I don't remember which report it's in, but I did -- I do recall seeing it that they tested it and, you know, there was not a problem there in terms of any substantive effect on the accuracy of the solution with the method that they did use. And I'm talking about the numerical accuracy of the solution.

Q. I guess what I'm asking --

MS. BAUGHMAN: Wait. Were you finished?

THE WITNESS: I was going to say a little more but, you know, --

MR. DEAN: Go ahead.

THE WITNESS: -- I was essentially finished.

BY MR. ANWAR:

Q. Go ahead if you'd like to say anything more.

A. Well, and I can't remember, again, where it was but, you know, the whole issue of numerical dispersion as it might be influenced by

a Courant number being exceeded or a Peclet number being exceeded. These are one of the ways to look at it and control to make sure your grid spacing and time stepping is not so big that it creates inaccuracies in the solution and, you know, I raised it as a question.

I didn't know that. I had no assessment that there were numerical deficiencies there, but I raised it as a question. They addressed it. It's in described in some of the reports -- I don't remember which ones -- and everything looked fine.

They describe that their Courant number was consistently less than 1 and the Peclet number consistently less than 2, and these are kind of standard criteria that you want to see met in solving the transport equation for groundwater.

Q. I guess what I'm asking is: Can you -- can you point to any document or anywhere where you expressed that your concerns had been addressed prior to your retention as an expert in this litigation?

MR. DEAN: Objection to the form.

THE WITNESS: Where I -- you mean where I said they were addressed?

BY MR. ANWAR:

Q. Correct.

A. No. I mean, I felt they were addressed, but I would have no reason to write that anywhere once my service on the panel was done.

Q. And --

A. Which was done after my service on the panel that they prepared, and so I was never asked for anything until I was hired for this litigation.

Q. And now your feelings are reflected in your -- your rebuttal expert report; is that right?

A. No. My rebuttal report is commenting on Spiliotopoulos and Hennet's report. It's not commenting on my original concerns.

Q. Okay. I noted that in a number of places -- well, let me start.

I want to turn your attention back to your -- your rebuttal report, and on page 2 sort of the end of your Introduction section, you

state:

"I hold these opinions to a reasonable degree of scientific certainty."

A. At the top of the page?

Q. Correct.

Do you see that?

A. Yeah. Yes, I do.

Q. And my question is to you: What do you mean there by a "reasonable degree of scientific certainty"?

MR. DEAN: Object to the form. It calls for legal conclusion.

THE WITNESS: Well, let me read --

BY MR. ANWAR:

Q. Sure.

A. -- the background.

(Reviews document.)

Okay. I think to summarize what I meant is that the opinions I express in here in terms of critiques or reviews of what was said in those expert reports, I stand behind them. I think there's a scientific basis for my comments and they're based on my, you know, 50 years of

experience as a hydrogeologist and groundwater modeler and that, yeah, I stand behind these opinions that are in this report.

Q. Okay. Are you opining that the simulated monthly contaminant concentrations produced by the two ATSDR models, Tarawa Terrace and Hadnot Point/Holcomb Boulevard, are accurate to a reasonable degree of scientific certainty?

MR. DEAN: Object to the form.

THE WITNESS: I -- I think they're accurate to a reasonable degree. I think they're as likely as not to represent what happened.

There's, you know, there's a band of uncertainty about the results that their or the calculations by their best fit parameters and best fit model, but the calibrated results, I think, are scientifically defensible based on state-of-the-art modeling and standard practices in the field of groundwater.

BY MR. ANWAR:

Q. You mention the phrase "as likely or not."

What does that term mean to you?

A. It means, as far as I could tell, I mean, I think I've seen that somewhere in all the documents I've been reading.

You know, it means this could be exact or maybe it's not, you know, exactly what happened. But in assessing the likelihood of this being right, it's just as likely to be highly accurate or -- or not. It may be off, but everything is done with a recognition of uncertainty.

But these are the best estimates and they're consistent with standard practices and, you know, that's -- we don't know with certainty that it's accurate and precise and represents exactly what happened, but there's a good chance that it is.

Q. It sounded like you were saying it's as likely as it's right as it is wrong.

Is that what you're saying?

A. Well --

MR. DEAN: Object to the form.

THE WITNESS: I don't know if that's exact. I won't say that's exact.

What I meant is, well, these are good estimates and they're based on scientifically defensible approaches with state-of-the-art tools. There's no reason not to believe them.

BY MR. ANWAR:

Q. So the phrase "as likely or not" is a phrase that actually comes from the statute that created this litigation.

A. Okay.

Q. And I'm just wondering: Have you ever used that phrase before prior to -- to your -- your expert work in this litigation?

A. Not that I remember. It's possible I did, but I don't recall.

Q. Where did your understanding about "as likely or not" come from?

A. The words. What it sounds like it means.

Q. Did you understand that's a legal standard in the statute that we're litigating?

A. I did not know it was a term in a statute, no.

Q. And you're not a lawyer; right?

A. Absolutely not.
Q. And you're not offering any sort of legal opinions; correct?
A. Nope. That's correct.
Q. I wanted to -- let's -- let's turn to the page 32 of your report.
MR. DEAN: Page what?
MR. ANWAR: 32.
MR. DEAN: 32.
MR. ANWAR: Correct.
BY MR. ANWAR:
Q. Let's focus on -- so this is the Conclusions section of your report.
Do you see that?
A. Yes.
Q. Okay. And that second paragraph states:
"Although Dr. Spiliotopoulos repeatedly questions the accuracy of the ATSDR model and its calibration, I don't see any evidence that it is unacceptably inaccurate."
What do you mean by "unacceptably inaccurate"?
A. That there would be obvious errors

in or results that are based on errors in the calibration of the model or in the use of parameter values.

Q. Are there acceptable inaccuracies?

A. Sure.

Q. What are some of the acceptable inaccuracies?

A. Well, I mean, if you say the hydraulic conductivity is 10 feet per day, but somehow our measurement says it's 12 feet per day or 8 feet per day, that's an acceptable inaccuracy.

First of all, you would never really know what the true value is, and it depends on many things in how you measure it, the method of measurement the scale of the measurement and so on. So let's say the truth is a little elusive.

Q. But there are inaccuracies; right?

MR. DEAN: Object to form of the question.

THE WITNESS: Every model is a simplification of complex reality. It involves approximation, assumptions, and averaging.

So yes, there's -- there's always uncertainty and certainly errors in every model, and what you try to do in standard practice is assess how serious those errors might be, how they might affect the results.

You do sensitivity tests and uncertainty analysis to help assess what confidence you should have in the model because we recognize that the model is not the reality.

BY MR. ANWAR:

Q. At the bottom of the Conclusions, that last paragraph that spills onto the next page, you start:

"In my opinion, ATSDR has done an admirable job in completing a challenging task of using hindcasting with a calibrated model to reconstruct credible concentration distributions in time and space prior to the availability of data from chemical analyses of groundwater samples in the mid-1980s. In the face of missing historical data, the ATSDR's models provide useful input to epidemiological studies."

Did I read that correctly?
A. Yes.
Q. I think earlier we had discussed -- I had asked you the purpose -- I had asked you questions about the purpose of ATSDR's model and the fact that the data, the information would be used for epidemiological studies.
Do you recall that?
MR. DEAN: 123 now. Yeah.
MR. ANWAR: Okay.
MR. DEAN: We all do.
THE WITNESS: Yes, I do.
BY MR. ANWAR:
Q. And in response to some of those questions, you -- you made clear you're not an epidemiologist; right?
A. Yes.
Q. So what is the basis for your opinion there "the ATSDR models provide useful input to epidemiological studies"?
A. My understanding was the epidemiological studies required first concentrations in the water supply wells, but ultimately concentrations in the water treatment

plants. That was my understanding of what was needed, and that's my understanding of what the modeling provided.

Therefore, I said, well, that's useful. It's providing useful input. That's why they wanted the models and the model -- the models provided that. So my inference was that was useful.

Q. And so if we skip a couple lines ahead, there is -- starting with the fourth line down, there is --

A. Which page?

Q. The last page, page 33.

A. Okay.

Q. It says:

"There is uncertainty in the calibrated models (as there always is in such models) and in the hindcasted results, and that is clearly recognized and evaluated. The uncertainty is not so large or unexpected as to preclude the use of the model results in the epidemiological studies or for providing mean monthly -- monthly mean concentrations for use by health professionals to estimate past exposure of

residents on 'as likely than not' or 'more likely than not' basis."

Did I read that correctly?

A. Yes.

Q. Did you -- did you write that sentence?

A. I did and those --

Q. Why did you -- go ahead.

A. You know, those terms "as likely as not" or "more likely" I probably heard from the lawyers and so that was -- I felt, yeah, that was a good description, but they did not tell me what to write or how to write it or anything like that.

I mean, that's probably -- I'm sure I heard those terms from the lawyers, and so I felt it appropriate to use it --

Q. Okay.

A. -- with, you know, my perception of what that meant.

Q. Got it.

And you say:

"The uncertainty is not so large or unexpected as to preclude the use of the model results in the epidemiological studies."

And we talked about the epidemiological studies, but then you go on to say:

"Or for providing monthly mean concentrations for use by health professionals to estimate past exposure of residents on an 'as likely as not' or 'more likely than not' basis."

You're not a health professional; correct?

A. Correct.

Q. So what is -- what is the basis for your opinion that the simulated concentrations from the ATSDR models are -- do not preclude the use by health professionals to estimate past exposure of residents?

A. Well, from the health perspective, I have no basis for saying that.

But from the modeling perspective, I felt that the mean monthly concentrations were estimated on the basis of reasonable, adequate models and so that they could be relied on for other purposes. But it's certainly not meant to imply I understood the health studies.

Q. Are you offering the opinion that

the simulated concentrations produced by ATSDR models are sufficiently accurate for health professionals to rely upon?

A. I think they're the best that could be come up with. From -- I think they're reasonably accurate. I think they're reasonably reliable. I think there's uncertainty associated with them.

I think the uncertainty is clearly expressed in the analyses produced by ATSDR, and then it would be up to the health professionals to decide with that level of uncertainty is it good enough for them to use. That would not be something I would say. So yeah.

Q. Earlier we had a discussion or an exchange where I was asking you about the intended purpose or use of particular models, and I believe you told me, as a modeler, the use of the model isn't really your focus or your concentration for purposes of developing the model; is that right?

MR. DEAN: Object to form of the question.

THE WITNESS: I would design a model, develop the model, calibrate the

model according to best practices in my understanding, regardless of what the downstream use of that model might be.

Although as I said before, I might refine the grid or do something particular to help meet the needs of the people paying for the model.

BY MR. ANWAR:

Q. But you're not -- and we -- we talked -- you're not a health professional yourself; correct?

A. Correct.

Q. Did you -- in forming this opinion, did you speak with any health professionals?

A. No.

Q. So it's your opinion, as a modeler, that the simulated concentrations from the ATSDR models are -- are good enough for health professionals?

A. Well --

Q. And when I say "good enough," I mean accurate enough.

A. I think they're reasonably accurate. Again, I'm not a health professional. So I

really -- I really shouldn't comment on whether it's good enough for a health professional.

Q. Well, if you don't feel comfortable commenting on the results being good enough for a health professional, why do you feel comfortable commenting on the results being accurate enough for a health professional?

MR. DEAN: Objection to form of the question. It mischaracterizes his testimony 100 percent.

BY MR. ANWAR:

Q. You can answer.

A. Excuse me?

Q. You can answer.

A. Well, as a hydrogeologist and an experienced modeler, I felt that these results were reasonably reliable, and I could think of no reason that they shouldn't be used in light, you know, with consideration of the uncertainty, why they shouldn't be used for any purpose after that.

Q. How many -- if you had to estimate, how many groundwater and/or transport models have you developed yourself or evaluated throughout your career?

A. Probably on the order of half a dozen comprehensive, detailed studies and model developments that I've done. And in terms of reviewing or assessing others, probably many tens, if not well over a hundred different cases, probably even more.

Q. Of all those models, are ATSDR models -- are ATSDR's models the only one you're aware of that are -- that estimate -- that are attempting to be used to estimate exposure -- monthly contaminant concentrations for exposure determinations in individuals?

MR. DEAN: Object to the form.

BY MR. ANWAR:

Q. You can answer.

A. Well, as I mentioned earlier, the analyses for the Waste Isolation Pilot Plant used models for 10,000 years into the future, and that was for the purpose of health exposure of a potential hypothetical future farmer and so it was used for health assessments. I don't recall what the health assessment studies were or how they were done, but it was used. That was one of the purposes of that modeling.

There are many other models that I reviewed with similar characteristics, but most often I say they do not describe what the sponsors of the modeling effort were going to do with it. So a lot of times.

So I guess my answer is, they may or may not have been used for health exposure studies. I don't know because I wasn't always aware of what the ultimate purpose of the model was.

Q. Okay. There are places in your report -- and I can give you examples if you'd like -- where you -- so, for instance, on the page we were just looking at, the last line of your report, you state:

"The methods were rigorous and scientifically sound."

Correct?

A. Yes.

Q. And then there are other places throughout your report where you refer to scientifically valid methods being used and/or the models being scientifically valid, the ATSDR models.

Do you recall that?

A. I don't recall saying they were scientifically valid, but I may have said that.

Q. Okay. Well, why don't we -- why don't you turn to page 30 of your report.

A. 30?

Q. Yeah.

A. Okay.

Q. Sorry. I might have put the wrong page on. Give me a second.

Oh, I'm sorry. Yeah. It is starting on 30.

At the bottom of 30, that last paragraph has a section heading "Section 3.3 and scientific validity of ATSDR model -- ATSDR's models," and you quote an opinion offered by Dr. Spiliotopoulos there where he -- he opined:

"I do not think their results were scientifically valid because" -- or I think you quote Dr. Waddill, actually.

A. Yes.

Q. And it says:

"I do not think their results ... were scientifically valid because, you know,

science needs to be based on real-world observations and analysis ... and there were just not enough real-world measurements for this to count as scientifically valid."

And you disagree there.

And then on the next page, on page 31, the second line:

"Therefore, I would counter Dr. Waddill's statements by noting that in developing and applying the ATSDR groundwater models, that scientifically valid methods were used, and the models were based on sound hydraulic and physical principles that themselves have been tested and shown to be accurate and reliable approaches to describing and predicting groundwater flow and contaminant transport."

Did I read that correctly?

A. Yes.

Q. Okay. Is it your opinion that ATSDR's Camp Lejeune water models are scientifically valid?

A. Yes.

Q. Why do you say that?

A. The models are based on a

mathematical representation of the processes that govern fluid flow in porous media and the movement of dissolved chemicals. These equations are well accepted throughout the scientific and engineering worlds.

There's common practice, standard practice. There may be some debate in the scientific circles, particularly about the governing solute transport equation, what it should look like but, nevertheless, it is a standard form. And these equations and the numerical methods to solve them are widely accepted as being scientifically valid and appropriate and useful.

So these -- these are the models and methods that ATSDR used and applied and, you know, I think what they do is estimate how water fluxes and water levels and solute concentrations, how they change over time in a way that is consistent with the widely accepted principles reflected in the governing equations.

This is -- this is valid science. This is, you know, well accepted. You know, there's very few people that would argue with

that, you know. So I think, yes, it is scientifically valid.

MR. ANWAR: Okay. I'm going to hand you an exhibit that I'm marking as Exhibit 14.

(Document marked for identification as Konikow Exhibit 14.)

BY MR. ANWAR:

Q. This is an editorial that was coauthored by you and a J.D. -- you pronounced it earlier -- Bredehoeft?

A. Bredehoeft.

Q. Bredehoeft. Entitled "Ground-Water Models: Validate Or Invalidate"; correct?

A. Correct.

Q. And we can -- we can read through this a little bit, but the first bolded section there -- so it was originally -- let me take a step back.

This editorial was originally published in 1993; correct?

A. The editorial? It says reprinted from 1993. The ideas expressed in here are really based on a more comprehensive analysis and article

that Bredehoeft and I published in, I believe, 1992.

Q. Okay. What is the name of that publication?

A. I think it was "Advances in Water Resources" is the name of the journal.

Q. And then this editorial was republished in "Groundwater" in 2012; correct?

At the bottom note.

A. Yes.

Q. So the first paragraph focuses on validation and it states:

"The word validation has a clear meaning to both the scientific community and the general public. Within the scientific community the validation of scientific theory has been the subject of philosophical debate."

And then you reference Karl Popper.

Going to the second paragraph there, you state:

"To the general public, proclaiming that a ground-water model is 'validated' carries with it an aura of correctness that we do not believe many of us who model would claim. We can

place all the caveats we wish, but the public has its own understanding of what the word implies. Using the word 'valid' with respect to models misleads the public; 'verification' carries with it similar connotations as far as the public is concerned.

"Our point is this: using the terms 'validation' and 'verification' are misleading, at best. These terms should be abandoned by the ground-water community."

Did I read that correctly?

A. Yes.

Q. And so when you're describing ATSDR's model as scientifically valid --

A. I never said that their model was valid. I never said it was validated. I never said anything about validation of the models.

I said the -- I try to avoid using the term "valid" or "validation." I used it once or twice in terms of overall broad scientific validity reflecting that it's a widely accepted method.

Q. I think I just asked you the question, is it your opinion that ATSDR's models

are scientifically valid, and your response was yes.

Is it?

A. Well, okay, but, you know, if you read the paper, what I don't want to imply is that the model is perfect or that there is no other model within the realm of infinite possibilities of combinations of parameters that would not do as well in terms of accuracy.

So it's not a unique model. It's valid in a broad sense of that term, but there is no exercise that validated their model. But it's valid scientifically in the sense of using state-of-the-art methods.

Q. What do you mean "there was no exercise that validated ATSDR's models"?

A. They went through a calibration, which involved history matching, and that calibration yields a best fit to the parameters, but it's not the only possible fit. History matching by itself does not prove that the model was valid, that it was the absolute truth.

We know it's not. That's why we do uncertainty analysis and sensitivity analyses.

Q. Your -- your report is directed to an audience of people that are not modelers; correct?
A. Which report are you referring to?
Q. I'm sorry. Your rebuttal expert report in this case; correct?
It's directed towards an audience that all aren't necessarily modelers; correct?
A. Yeah. I mean, it's aimed at you and others that aren't hydrogeologists, as well as aimed at technical experts in hydrogeology.
Q. Isn't using the terms "valid methodology" or "scientifically valid" or describing the model as "valid," isn't that, as you state in your own words here, misleading?
MR. DEAN: Object to the form of the question.
THE WITNESS: Well --
MR. DEAN: Mischaracterizes his prior testimony. He's already answered that question.
THE WITNESS: Let me emphasize that bringing up this topic of validity was not mine. It was brought

up -- I'm quoting from Spiliotopoulos.
He raised the issue and so I'm trying to
address it.
It is not -- it's not a
terminology that I would normally use for
the very reasons we discussed and
summarized in that editorial.
BY MR. ANWAR:
Q. And the first sentence of that
second paragraph:
"To the general public, proclaiming
that a ground-water model is 'validated' carries
with it an aura of correctness that we do not
believe many of us who model would claim."
"Using the word 'valid' with respect
to models misleads the public."
Isn't describing ATSDR's models as
scientifically valid or the methodology they used
as scientifically valid, isn't that intended to
carry with it an aura of correctness that you
acknowledge?
A. I don't think they ever said that
they validated their model. I don't think that
terminology was ever used with respect to their

modeling of the results.

The ATSDR is very clear and very transparent about recognizing uncertainty in the results.

Q. They -- go ahead.

A. So they're not anywhere in my reading implying that they have the right truth or model or that they validated it in the sense of it being the ultimate pinnacle of correctness. I don't think they ever implied that. They certainly never say that, and I think that's why we use.

What they've done clearly in many, many, many plots of results, they show the calculations based on their best fit calibrated model, and they show upper and lower bounds about that that reflect some range of consideration of uncertainty in one or more parameters.

So I think they're very clear in expressing that they have not validated the model in the sense that people could misinterpret it to mean that they have an aura of correctness and certainty about their results.

Q. ATSDR didn't validate their model

because they couldn't validate their model; right?
MR. DEAN: Object to the form of the question.
BY MR. ANWAR:
Q. There wasn't sufficient data to validate their model; correct?
MR. DEAN: Object to the form.
THE WITNESS: That's very misleading as I read it because there is never ever any groundwater model for which there is sufficient data to say (indicates) you've validated it. It just doesn't exist.
There is always uncertainty. Every model ever developed for groundwater has uncertainty associated with it, and no competent hydrogeologist would claim that they have the truth.
BY MR. ANWAR:
Q. What is your understanding of why ATSDR didn't validate their models?
MR. DEAN: Object to the form of the question.
THE WITNESS: Repeat the

question.

BY MR. ANWAR:

Q. What -- having reviewed the reports, the Tarawa Terrace reports and the Hadnot Point/Holcomb Boulevard reports in preparing for your deposition and offering expert opinion in the case, why didn't ATSDR just validate their two models?

A. Well, the title of the paper I published in 1992 with John Bredehoeft is groundwater models cannot be validated. That did not refer to ATSDR or Camp Lejeune. It referred to every groundwater model ever developed or potentially developed in the future.

It's in our opinion -- and not everyone agrees, but in our opinion, no groundwater model could be validated in the sense that the public might perceive the term to imply that you have the right model to the exclusion of any other possibility.

So if ATSDR had claimed that they validated the model, I would have come down on them very hard, severely criticized them for saying that, but I think they knew better than to

say that.

Q. Okay. Describing a groundwater -- groundwater model as scientifically valid or the methodology that was used as being scientifically valid doesn't mean that the output, in this -- in this case the simulated concentrations produced by ATSDR's models, are accurate; right?

MR. DEAN: Object to the form.

THE WITNESS: It depends how you mean "accurate." They're not precisely the truth because we don't know the truth. They're not, you know, they're reasonable and they represent what's going on, but there's uncertainty about it.

It could be a little higher. It could be a little lower. This is the best estimate in the middle. It's a moving trend based on a very reasonable model that solves the governing equations.

The equations for which we know represent the processes, but the coefficients in the equation are not

known precisely, and they are never known
precisely or accurately.
BY MR. ANWAR:
Q. Okay. I think you stated or I believe it's listed on your reliance materials that you reviewed Jones and Davis's original postaudit report; correct?
A. I read it. It was probably a couple of weeks ago. I didn't give it a technical review in great depth, but I did. I looked at it, yeah.
Q. Did you also look at their -- I can't recall, so I apologize if I asked you this already.
Did you also look at their rebuttal expert report submitted in this case?
A. I think I did, yes.
Q. There is a portion in their report where they state:
"Based on this postaudit, we can find no significant evidence that would invalidate the analysis performed by ATSDR with the original model."
Are they using the term "invalidate" then incorrectly?

MR. DEAN: Object to the form.
THE WITNESS: Well, I would assume so. You know, the general belief, John Bredehoeft and I and many others believe that you can invalidate a model, but you cannot validate it. And by invalidating, you show that there are significant errors from what's going on.
So if you -- the basic reasoning -- I'm not sure who said this first but, you know, if you have a model, you have best fit, your history match, and all of that. That builds confidence in the model, but it doesn't prove you have a valid model.
If you make a prediction and that prediction turns out to be wrong by some substantial degree, you have in effect invalidated the model and you try to get a better model.
But if the next prediction, you know, that prediction you made turned out to be really close, that builds more confidence, but it still doesn't prove

that you validated the model because the very next prediction might be erroneous.

So the kind of philosophy -- philosophical argument is that you can never validate the model in any kind of literal sense, but you can invalidate it by showing that it was inaccurate.

BY MR. ANWAR:

Q. Isn't validation a history matching, a form of history matching?

A. What I would argue is that they are not equivalent. History -- if you match history very well, that doesn't mean you validated the model. It means you have more confidence in the model. The model is probably pretty good.

Q. If you have history matched very well, why does that not validate the model?

A. Because the next prediction could be off. You may not have data for a particular point or thing where it may have been an error. You never have enough to say, this is the perfect model and it's a valid model or you validated it. Because you make a prediction, that could turn out to be wrong.

So the general cautiousness that you want to say is that you've got a good model, a reasonable model. We've matched the history, the historical data that we have. We have a good calibration, and we think this is an appropriate model, a reasonable model for the purposes that we're using it.

But we don't say that it's validated because I would argue that you can never validate a model because you never, you know, you just don't know what will happen in the future.

Q. So my understanding of calibration and validation is -- and you should correct me if I'm wrong -- is essentially that you -- when you're calibrating the model, you're attempting to adjust parameters to match observed parameters such that the simulated results matches closely as possible observed values that you're running the model against.

And validation is taking a set of observed values that you didn't use as part of the calibration and then comparing the simulated models against sort of a separate set of observed data.

Is my understanding right?

A. I would say it's not right, but it matches the perception of many other people. You know, I think there are people who believe that.

I would counter that in groundwater systems, you can almost never have independent data sets. If you have, you know, your observations say, well, let's save this for the (indicates) what you might call validation, you're not blind to that data. You know what it is. It's not.

You know, in drug approval, they would never say that that's acceptable for a drug test because you are aware of what those values were. You weren't blind to them, and they're not an independent set of data.

You never have an independent set of data in a historical groundwater. Everything is linked and in groundwater systems, even if you can compare it with surface water systems, surface water, without the issue of validation, you could get a fairly independent set of responses in a river flow data if you go down a year or two in time in response to different precipitation

events.

In groundwater systems, the responses are much more buffered and much more slower, and the behavior of a groundwater system a year in the future depends to a large degree on what it was at the start of that year.

You don't get independence and that restricts your ability to even talk about validation with an independent data set because it's so difficult to get in groundwater system anything that approaches an independent data set, and I would argue that still revealed validation if you had.

Q. I guess the reason I asked -- part of the reason I asked that question: If it's your opinion that you can't validate a model ever under any circumstance, how can you ever calibrate a model? How can you say that any model --

A. The calibration has nothing to do with validation in the sense. You can calibrate. What you do in model calibration is adjust parameters and boundary conditions and maybe some other processes, maybe your numerical grid, maybe your time step. You adjust lots of things so that

the results match the historical changes that you've seen. You could do this. It doesn't depend on any condition (indicates) called validation.

It's the process of model calibration is the process of parameter restoration in effect, and that's why automatic or automated parameter estimation models are so useful because they make the whole process faster and more efficient to adjust parameters to get what could be a statistically best fit.

Q. Is it possible to adjust the parameters in a model in such a way that the -- that you successfully -- let me -- let me start -- strike that.

Talk to me about the concept of nonuniqueness.

MR. DEAN: Object to form.

THE WITNESS: Excuse me?

MR. DEAN: Object to form.

BY MR. ANWAR:

Q. What is nonuniqueness in modeling?

A. Well, that's basically the concept that when you calibrate a model, you have a set of

parameters that you feel give you the best fit but that may not be the only combination of parameters that give you approximately an equally good fit.

You know, there's, you know, if you -- if your result is a sum of 10, 5 plus 5 gives you 10 or 6 plus 4 gives you 10, and in terms of the fit, they're both equally good.

Q. And so when we're talking about calibrate -- adjusting parameters to calibrate a model, there -- there are many different possibilities of combinations of parameters that could calibrate the model in the sense that the simulated values match the observed values; correct?

A. As well as possible. What you do that -- I mean, it's not an unbounded process. What you do is you consider the -- how good the fit is and the quality and the errors and the mean error and all the other statistical measures of the fit. And you adjust parameters until that error measure gets smaller and smaller, and continued changing of parameters basically yields no improvement, no further improvement in fit, and that's why you say, well, that's as good as we

could do.

Q. And simply calibrating a model or -- excuse me -- simply adjusting parameters in a way that to calibrate a model doesn't mean the model is good or accurate if the input parameters are unrealistic; correct?

A. Well, one of the guidelines for adjusting parameters during history matching during calibration is you have to keep those bounded within reasonable limits. You know, that's, you know, whether you're doing by trial and error or with an automated method, you don't have an unlimited range to adjust parameters.

You can't have a negative value of hydraulic conductivity. You know, you have to be consistent with principles and your geologic knowledge and other maybe more subjective criteria, but it's not an unbounded universe.

Q. The statistical analysis that you're talking about to -- to ensure that the model is appropriately calibrated and the parameters fall within a certainty bound, ATSDR didn't do that statistical analysis for the Hadnot Point/Holcomb Boulevard model; right?

A. I'm not sure what you mean. I mean, they did a model calibration. They were measuring the goodness of fit. They -- my understanding is that they used the PEST software to help with the calibration and parameter. That PEST automatically calculates all those measures of fit and that's how it does the calibration, by minimizing some objective function that's related to the error.

Q. Okay. Why don't we take a quick break.

A. Sure.

MR. ANWAR: A short break.

THE VIDEOGRAPHER: Going off the record. The time is 3:51 PM.

(A recess was taken.)

THE VIDEOGRAPHER: We're back on the record. The time is 4:05 PM.

BY MR. ANWAR:

Q. We are back on the record from a short break.

Dr. Konikow, are you okay to continue?

A. Yes.

Q. Okay. And did you speak with your lawyers about the substance of your testimony?

A. No.

Q. Okay. I wanted to ask you.

Can a postaudit be used to validate a model?

A. No.

Q. Why not?

A. Because a model can't be validated.

Q. And looking back at your -- this editorial, it is, I think, Exhibit 13.

A. 14.

Q. 14. Thank you.

If you turn to the next page, there is a section on Postaudits, and you state there:

"Several postaudits have been performed to evaluate the accuracy of predictions made using -- sorry, lost my place -- made using supposedly validated -- 'validated' models. Compared to the number of model studies, the number of postaudits is small. There are numerous problems in examining past predictions; often the stress placed on the system was quite different from that used in the model analysis.

"The results of the current set of postaudits suggests that extrapolations into the future were rarely very accurate. There are various problems with the models: the period of history match was too short to capture an important element of the model, or the conceptual model was incomplete, or the parameters were not well-defined, etc. Our experience suggests that models are more useful as tools used by the hydrologist to understand the system rather" -- it says "that" but I think it's -- "than as tools to predict future response. Our record of 'validating' models is not encouraging."

Did I read that correctly?

A. Yes.

Q. Okay. So you can use a postaudit to evaluate the accuracy of the predictions of a model; correct?

A. No.

MR. DEAN: Object to form.

THE WITNESS: That's not correct.

BY MR. ANWAR:

Q. Okay.

A. You could use the postaudit to assess the accuracy of the predictions made by the model, how good the model was, but it just would not prove that you had a valid model.

Q. Okay. And why -- why wouldn't it prove that you have a validated model?

A. Because if you use the model, the same model to predict another year into the future, that may be very wrong. That prediction may be wrong and, therefore, that would prove you had an invalid model. It would invalidate the model.

So when you use a postaudit to assess the accuracy of the prediction, if it turns out -- which doesn't always happen -- if it turns out that the prediction was fairly reliable and acceptably accurate, it helps build confidence in the model. You're building confidence in the model. You feel better about the model.

You just have not proved that it is a valid model. You have not validated the model because the next prediction could be very much in error with the same model, and that would invalidate the model.

Q. Okay. Understand.
Can you pull up Exhibit 12. It is the 2005 transcript of the expert summary, day 2.
A. Which one is 12?
Q. It's the transcript of the expert panel. I think we have only given you one of those so far. Should be one of the thick ones.
A. Yeah, thick ones. This is 9. 13.
Q. There you go.
A. 12. Okay.
Q. Could you turn to page 46?
A. Okay.
Q. Okay. So just for frame of reference purposes, the 2005 expert panel was focused on ATSDR's Tarawa Terrace model; correct?
A. Yes.
Q. And so starting at line 14, there's a discussion going on and you chime in at line 14. You say:
"But the point -- one of the points is that you really -- your study isn't starting until 1965."
And Maslia says '68 and you say '68.
"That gives you 14 years from the

time ABC Cleaners started. So the value in doing the groundwater flow and transport model will be to, you know, start as best as we -- or as best we know. They were introducing contaminants into the soil at least through the septic tanks very shortly after they started, maybe a year, maybe instantly, maybe a year, maybe two years at most. That gives you 12 years for it to reach the water table and spread."

"The" -- going into the next page.

"The groundwater flow and transport models accounting for uncertainty" --

A. I'm not sure where you're reading from now.

Q. On page 47 line 1.

A. Okay. Okay.

Q. Just continuing from where we were reading.

"The groundwater flow and transport models accounting for uncertainty, heterogeneity, and so on will give you a range of arrival times, but I'm guessing the bulk of your realization will get contaminant reaching the wells in that 14-year period."

Did I read that all correctly?
A. Yes.
Q. And it sounds like in this exchange, you're talking about here mass loading at Tarawa Terrace; correct?
A. Well, we're talking about, yeah, the solute load. Yeah, when the source got to the water table and then spread down to TT-26 and so on.
Q. And the way I read your comments here is that, you know, you say:
"ABC Cleaners, they were introducing contaminants into the soil at the very least through the septic tanks very shortly after they started, maybe a year, maybe instantly, maybe a year, maybe two years at most. That gives you 12 years for it to reach the water table and spread."
You're discussing --
A. I did not mean that it would take 12 years to reach the water table.
Q. Okay.
A. I meant that it would reach the water table, and then it had 12 years to spread. Until that, you know, 1968 time.

Q. It does sound like you're saying here, though, that the contaminants wouldn't reach the water table on day one; right?

A. On day one? Probably not.

Q. And you indicate that "maybe a year, maybe two years at most"?

A. Yeah, I really think it would be less than that.

Q. But at this time, you stated "maybe a year, maybe two years at most"; right?

A. Yeah, that's what I said. Yeah.

Q. And, again, when you're referencing 1968, you're talking about the starting point of the EPI study that ATSDR was performing; right?

A. I believe so.

MR. ANWAR: Okay. I'm going to hand you what I'm marking as Exhibit 15.

(Document marked for identification as Konikow Exhibit 15.)

BY MR. ANWAR:

Q. This is the transcript from day 1 of the 2009 expert panel; right?

A. Apparently, yes.

Q. And it's dated April 29, 2009 there; correct?
A. Yes.
MS. BAUGHMAN: Did you hand us one?
MR. ANWAR: Yeah, it's right there.
BY MR. ANWAR:
Q. I'd like you to turn to page 89.
And in the middle of the page there, your name is highlighted starting on line 7.
Do you see that?
A. Line 7.
Q. On page 89?
A. Yes.
Q. You see that?
A. Yes.
Q. It says:
"DR. KONIKOW: The Tarawa Terrace with the first arrival in November '57, if that was actually several years later, maybe even four or five years later, would that have any effect on the health study since the health study is '68 to '85?"

Did I read that correctly?
A. You read it correctly.
Q. And so you're -- you're raising whether an even later contaminant mass loading date would impact the -- the EPI study that ATSDR was performing; correct?
MR. DEAN: Object to the form.
THE WITNESS: I seem to be talking about the first arrival, and I am inferring that might be talking about TT-26, but I don't see. I haven't carefully read right now the preceding several pages.
So when I said "first arrival," I'm inferring that meant at TT-26, but I'm not positive that's what we were talking about.
BY MR. ANWAR:
Q. Okay. TT-26, was that the -- was that the primary source in Tarawa Terrace?
A. I believe so.
Q. Or that was the source was ABC Cleaners, but the TT-26 was the most contaminated well; correct?

A. Most contaminated well, yes.

Q. Okay. And so if we go on to read, Mr. Maslia states:

"We actually did, Mustafa Aral did some well scheduling optimization and did different scenarios with different wells other than the ones that we calibrated for the model. And you could shift from '57 to '60, but during the course of the study it did not significantly affect at all the higher concentrations.

"They all tended towards that level of that chart, the graph that shows in the finished water that all that it shifted was, other than if you shut down, for example, TT-26. If you shut down TT-26, both the data and the model would show that your finished water went down to practically no contamination at Tarawa Terrace. But if you shifted the cycling so that it didn't hit or arrive or pass the MCL, say, as you said, 59, 60, 61, whatever, did not significantly affect the higher concentrations in the finished water."

Did I read that correctly?

A. Yes.

Q. Okay. And because TT-26 was the --

I guess the most contaminated well, it sounds like he's saying -- Mr. Maslia -- that if you shut it down, the contamination levels went to nearly zero; correct?

A. He said that they would. He didn't say they shut it down. He said -- I believe he implied if you shut down TT-20 -- TT-26. That was because that was the main source, not the only but the main source, of contaminated water to the Tarawa Terrace Water Treatment Plant. If that wasn't pumping, then there would be few, very few contaminants showing up in the Water Treatment Plant.

I think that's what was implied there.

Q. Do you recall the extent of data available about the pumping history for TT-26?

A. I recall seeing it. I can't recite the details of it, but I know they had a graph showing when it was operating, and there was another graph showing estimated pumping rates from that and other wells. So yeah.

Q. Would you agree that there was incomplete data about the pumping history of

TT-26?

MR. DEAN: Object to form.

THE WITNESS: To the best of my knowledge, there was not a complete record of when the well was pumping and how much it was pumping. That had to be reconstructed also.

BY MR. ANWAR:

Q. And one of the assumptions that ATSDR made was to assume that the well was pumping unless there was a historical record confirming that the well was not pumping; correct?

A. Well, I don't know exactly what they assumed but, you know, certainly in terms of, they had methods to estimate what the average monthly pumping rate was. And if the well is shut down for a day or two during a particular month, then maybe your average withdrawal for that month would be a little lower.

But for the model, you would still a sum -- assume that it's pumping at that slightly lower rate but over the whole month, and it wouldn't make any significant difference in the results.

But as I recall, there were only two extended periods of non-operation of TT-26 before it was finally shut down, but I don't think that implied that it was never shut down. I think there was some statement that typically they cycle through all the different wells that supplied water, and so it was routine for any individual well to be shut down for a short period of time.

I think that's normal when you have multiple wells in a well field supplying it. I think it's normal to cycle through using different ones to meet the demands at the time.

Q. Okay. And so your recollection of the way ATSDR handled -- handled the model with respect to missing pumping history is that they cycled through?

A. No, that wasn't part of the reconstruction. That was part of the operation.

That the normal operation of wells, I believe, included cycling through different combinations of well pumping at any time, any particular time during the whole history, in other words.

So no one is saying that, the

Department of the Navy or anyone. They're not saying that TT-26 pumped continuously from the beginning to end of their pumping period before there was, you know, a longer break for servicing.

The normal operation includes short sequences in which the well is turned off, maybe minor servicing, but that's normal and it doesn't affect the model.

Q. How did ATSDR handle TT-26 for purposes of the historical reconstruction period?

A. You mean --

Q. The pumping. How did ATSDR handle the pumping schedule for TT-26 for purposes of the historical reconstruction period dating back to 1953?

A. I don't have a precise recollection of method they used, but it was well-documented in the report. I had read it. I just don't recall the details of it, but my recollection is that there was some estimates based on water demand, you know, how much the water treatment plants needed, and how that might have been apportioned among the different wells supplying it.

So there was some correlation,

regression analysis and reconstruction, and it is -- let me emphasize again that in all groundwater models, you require an estimate of the pumpage from all wells in the area and it is, I'd say, beyond common, it's almost in every case the models have to reconstruct the pumping history and make estimates of it.

Q. Understood.

A. It is rare that over a historical period you would have very precise records of pumpage.

Q. Let's turn to page 201, and starting at line 6 your name is highlighted there for comments you made; correct?

A. Yes.

Q. Okay. So it says:

"DR. KONIKOW: So then the question is how do you go, you'll calculate a mass, but then how do you go back in time and use that to estimate what the mass loading rate is over the duration of the model? The Tarawa Terrace situation you had essentially a point source with a known location and a fairly constant -- constant over time disposal rate. Here I'm not sure how

you're going to reconstruct the history of mass loading."

You're referring to Hadnot Point and Holcomb Boulevard; right?

A. I believe so.

Q. Why are you not sure how they're going to reconstruct the history of mass loading at Hadnot Point and Holcomb Boulevard?

A. Well, I wasn't sure because there were multiple sources. There was very little record. There were underground storage tanks that were leaking. They could discover where they were but not necessarily when they started leaking.

There were aboveground storage tanks. There were poor practices in industrial facilities. There was -- there were, you know, just multiple potential sources, and this was a logical question, I thought. How are you going to reconstruct it?

Well, I mean, they went ahead and reconstructed it, and they documented the methods they used and, you know, I mean, they did it. There's uncertainty associated with that.

MR. ANWAR: All right. Okay.

I'm going to hand you a different exhibit. Fortunately, it's another one of these big transcripts. I am marking this exhibit as Exhibit 16.

(Document marked for identification as Konikow Exhibit 16.)

BY MR. ANWAR:

Q. Now, in your report, quickly jumping back to Exhibit 2, on page 9, it is -- yeah, on page 9, you include a graphic F16 from the Tarawa Terrace reports.

Do you see that there?

A. Yes.

Q. Why did you include that graphic?

A. (Reviews document.)

Well, reading back, it looks like Dr. Spiliotopoulos included that in his report, and I wanted to discuss it. So I thought it might be of value. I didn't include too many figures in my report, but this is one I thought was worth including.

It --

Q. Go ahead.

A. Do you want me to comment on that

figure or...

Q. Sure.

A. Well, as I say here, he's commonly talking about the model being biased high or that the estimates were biased high in it. You know, I think he, you know, sort of cherry-picking results that emphasize that and ignoring the results that might counter it.

To me this, the figure that apparently he used in his report, is really the kind of results you want to see. The simulated results at the time of five of these observations falls right about a level of 800 when the observations range from about -- I don't know -- 3 or 30 up to about almost 1600. That is the simulated value falls right in the middle of that range, and to me that's a good estimate of -- a good illustration of where the model is doing a really good job.

It's -- that's, you know, when you're faced with the variability in the observed data over such a short time at one point in time, which sometimes it's hard to explain but, nevertheless, there it is. You can't expect the

model with monthly time steps to match every single one of those values. You want it to match the central tendency of those values, and that it did almost perfectly.

Q. Is it your opinion that this F16 figure shows a well-calibrated model?

A. Well, that it seems to be. It certainly is not evidence of anything being biased high.

And one of the things to note is that this is the record at TT-26, which was the most important water supply well in terms of contributing contaminants to the Water Treatment Plant.

If you could have said, without seeing the simulated results, where would you have wanted the model to be at that point in time, I would say right at 800.

Q. And so it's your opinion that -- just to be clear, it's your opinion that Figure 16 shows TT-26 at least -- let me -- let me ask that again.

Is it your opinion that with respect to TT-26 the model -- this figure demonstrates the

model is calibrated well?
A. At least at that point. Again, it doesn't prove there's a perfect match everywhere. It's just at this point, boy, you couldn't do any better. That's an important point. That location is an important location.
Q. Okay. Let's -- is it your opinion that ATSDR's Tarawa Terrace model does not overestimate contaminant concentrations?
A. I think there was evidence at some locations that it was too high, particularly TT-23. It was not a good match at that location, but in, you know, it's a model. You know, calibration yields some, you know, it's a best fit. Best fit by definition means at some point it's too high. At some points it's too low.
In this case, you know, for the Tarawa Terrace model, I think, you know, that's certainly true. In some places, it's too high. In some places, it's too low. It may be a little too high at more places than you'd like. So there is a slight, but I think it's not. I think Spiliotopoulos overstated the degree to which it overestimates.

Q. Turning back to -- I forget -- Exhibit 16, which is the transcript I handed you. This is day 2 of the transcript -- excuse me.
This is the transcript for day 2 of the 2009 expert panel.
A. Yes.
Q. Do you see that?
A. Yes.
Q. Okay. It's dated April 30, 2009; correct?
A. Yes.
Q. Okay. If you turn to page 216 in the transcript.
A. 2-1-6?
Q. Correct.
Are you there?
A. Yes.
Q. Okay. Your name is highlighted there in the middle starting on line 5.
A. Yes.
Q. It states:
"You kind of mentioned earlier that you have quite a lot of variability over short periods of time in the observed concentration."

Which is what I think you were just talking about?

A. Yes.

Q. And the next line is:

"That's really going to be a big obstacle to calibrating the model."

Did I read that correctly?

A. That's what I said at the time.

Q. Okay. And those are your words; correct?

A. Apparently.

Q. And Mr. Faye responds:

"It was and it is."

And you respond:

"Look at Figure F-16" the one we just discussed in your report. You say:

"Look at Figure F-16 in your Tarawa Terrace report. You have this simulated curve that's coming up, a nice smooth curve, and then there's one point in, I guess, 1985, where you have five frequently, sampled -- you have five frequently, samples collected over a short period of time."

And then you go on to say:

"And they have a range much greater than the long period of the --"

And then Mr. Faye cuts you off:

"I know. I know, Lenny. Let me make a comment on that. In part -- in part of my comment I'll reference, for example, the Table C-7, if you want to check that out."

And then he goes on to explain a lot the reasons for variability of concentration data.

I just wanted to confirm it.

As -- as of the 2009 expert panel, it was your belief that the figure that we were looking at demonstrated that calibrating the model was going to -- it was going to be a big obstacle to calibrate the model; right?

MR. DEAN: Objection to the form.

Read the next few pages of the transcript for him in context, not just a section on it.

MS. BAUGHMAN: You can read as much of it as you want before you answer.

BY MR. ANWAR:

Q. Well, let me ask this.

A. Okay.
Q. On page 216, the quote from lines 5 to 9, those are your words; right?
A. Yes.
Q. Okay. That's -- we can move on from that.
A. I assume I was talking about the Hadnot Point/Holcomb Boulevard model there.
Q. Why do you assume you were talking about the --
A. Because this was an expert panel on the Hadnot Point/Holcomb Boulevard model.
Q. Why would you immediately then refer to F16?
A. By "immediate," I'm not sure what you mean by immediately, but this is page 216 on the second day. So it wasn't immediate.
Q. No. I guess I mean: You make the comment about being a big obstacle to calibrating the model. Mr. Faye responds "It was and it is" and then you say "Look at F-16 in your Tarawa Terrace report."
A. That refers to Tarawa Terrace.
Q. Okay.

A. I can't -- I can't say that the previous comment was about Tarawa Terrace.

Q. Okay. So the -- the obstacle to calibrating the model was at Hadnot Point/Holcomb Boulevard?

A. I --

MR. DEAN: Object to the form.

THE WITNESS: I'm not sure, but that's -- without reading back, I think that's what we were talking about, but I'm not positive.

BY MR. ANWAR:

Q. Okay. Fair enough.

MS. BAUGHMAN: Just for the record, he didn't have time to read the pages before and after for context.

MR. ANWAR: The record may reflect that.

I'm going to hand you what I'm marking as Exhibit 17.

(Document marked for identification as Konikow Exhibit 17.)

THE WITNESS: Thank you.

BY MR. ANWAR:

Q. Exhibit 17 is a copy of Chapter F for the Tarawa Terrace model; correct?
A. Yes.
Q. And so I wanted you to turn to page 33. It's page F33, and on page F33 there's a figure, Figure F12; correct?
A. Yes.
Q. And Figure F12 is comparing observed PCE concentration versus simulated PCE concentration for the Tarawa Terrace model; correct?
A. Yes.
Q. And would you agree that Figure F12 shows the model to be overpredicting PCE concentrations?
MR. DEAN: Object to form.
THE WITNESS: I would agree that there are more data points above the solid line than below it, but what I would note is that at the real critical important high concentrations, the fit is very good.
I would also note that there are many or at least several duplicative

samples in here that really present a little bit of an unfair picture in that they're, you know, they reflect samples collected within a day or two at the same location and, therefore, shouldn't be plotted in a way that seems to give equal weight to each value.

BY MR. ANWAR:

Q. If you --

A. I think I discuss that in my expert report.

Q. But you would agree that F12 demonstrates that the model overpredicts. TT model is overpredicting; correct?

MR. DEAN: Object to form. Asked and answered.

THE WITNESS: It's a limited number of points. There are some points there that probably shouldn't be there. It doesn't include the agreement at locations or for data points where there were non-detects reported.

But in terms of what's shown in Figure 12, there are more data points

above, but that's not -- this is just for a limited number of observation points. It's not a reflection of the reasonableness of the whole model.
BY MR. ANWAR:
Q. Would you agree that calibration targets are subjective?
A. Targets?
Q. Yeah.
A. I would say so.
Q. And then, therefore, whether a model is calibrated is a subjective assessment as well?
A. Partly subjective. I mean, as a hydrogeologist, you would have a good sense as to whether or not you have a reasonable calibration, but that assessment is certainly at least in part subjective.
Q. What does the location of the observed concentrations relative to the line in Figure 12 tell you about the calibration and the fit of observed versus simulated concentrations?
A. Tells me at the high concentrations, the model did a really good job. Knowing some of the basis of some of the data, I think some of the

points probably should be lumped together and not shown as separate independent points. They're not independent samples.

It's a very -- relative to the number of calculations done in the model, this is an extremely, extremely small sample. But that's part of the problem that there just aren't that many observed concentrations certainly over time.

But yeah, I -- yeah, I mean, this table shows more values above that line of a perfect match than below it.

Q. And there in the text right above the last paragraph on F33, it says:

"Both results indicate that simulated PCE concentrations moderately to substantially overpredicted observed concentrations at water-supply wells."

Correct?

A. That's what it says.

Q. Okay. So ATSDR in its report indicated that the PCE concentrations were moderately to substantially overpredicted, right, at the water supply wells?

A. Well, what they said what you read

there. I would argue that they themselves gave equal weight to those points, and I argue in my expert report I point out that they should really consider the overall accuracy at each of the observation wells, which gives you a different picture. Not a perfect picture, but it gives you a different picture of the nature of the overprediction and the calibration.

And in my expert -- expert report, I think pointed out at 73 percent of the locations, the fit was within their calibration targets as opposed to the image given by in the report itself and as pointed out by Dr. Spiliotopoulos.

Q. Did you say 73 percent fell within the calibration standard?

A. In terms of the location, the individual wells. I can look in the report and see exactly what I said, but I think that's what I said.

Q. Okay. It's okay.

A. Yeah.

Q. We can -- we can come back to that.

Would you agree that groundwater data gets more independent the further apart the

data sets are in time?

MR. DEAN: Object to form.

THE WITNESS: I'm not sure I understand the question.

BY MR. ANWAR:

Q. Okay. Scratch that. We'll come back to that.

I guess the reference to that -- so let me -- let me backtrack to that -- that last question quickly.

I think you said -- and you correct me if I'm wrong -- that data points are -- the data points for -- it was F16 that we were looking at -- were not independent because they were too close in time; correct?

A. I don't remember if I said that they weren't independent. I said, you know, in Figure -- F-16 we're talking about?

Q. Correct.

A. I said they're close in time and they have a very large spread or a large variance in the values. The individual. The five values that are collected at this scale it looks like within a few days or so of each other show a large

range in concentration from close to 1600 to, you know, 10 or 20 or 30, very low value.

And that's a degree of change that I would not have expected in such a short period of time in the same location, and yet there it is. So I don't doubt that it happened. It's certainly been observed in other areas where you get such a big change in concentration.

So I don't understand the reference to independence, but each of those five samples were collected at the same location at slightly different times and they showed widely varying values.

MR. ANWAR: Okay. I'm going to hand you what is being marked as Exhibit 18.

(Document marked for identification as Konikow Exhibit 18.)

BY MR. ANWAR:

Q. This is an article that you published in "Groundwater" in 1986; right?

A. Yes.

Q. It's entitled "Predictive Accuracy of a Ground-Water Model - Lessons from a

Postaudit"?

A. Yes.

Q. I just had a couple questions about this article.

A. Okay.

Q. If you could turn to page 178.

A. 178?

Q. Correct.

A. Okay.

Q. There is Figure 8 there.

A. Yes.

Q. And you describe it as:

"Relation between predicted and observed changes in water level in the Tempe-Mesa-Chandler area of the Salt River basin, Arizona, 1964 to '74. Solid line shows where predicted equals observed values."

Did I read that correctly?

A. Yes.

Q. Okay. And it's very similar to -- understandably different site, different model, but the presentation itself is very similar to the figures we just looked at for -- for Tarawa Terrace; correct?

MR. DEAN: Objection to form.
THE WITNESS: In a certain sense, yeah.
BY MR. ANWAR:
Q. It's comparing observed versus predicted --
A. Yeah.
Q. -- values?
A. Yeah.
Q. And so if you -- underneath there, there is text under Assessment and Prediction. Second paragraph states:
"The relationship between the predicted and observed changes in water levels is illustrated in Figure 8. If the predictions were relatively accurate, the data should plot along (or close to) the 45 degree line connecting equal values of predicted and observed changes. Instead, data from all but three wells fall below that line, indicating poor accuracy and the presence of bias in the model predictions."
Did I read that correctly?
A. Yes.
Q. And in this article, you stated that

the model indicated poor accuracy due to the fit of the simulated concentrations, the observed versus simulated on the line; is that right?

A. Can you say that again?

Q. Sure.

In this article, you said because the simulated or predicted values fell below the 45 degree line --

A. Yes.

Q. -- that it indicated poor accuracy and presence of bias in the model predictions; correct?

A. Yes.

Q. And why is that?

A. The scatter was very large and the magnitude of the errors of the differences was very large. Much larger than in the example from Tarawa Terrace.

Here you have where the observed water level -- let's see -- some of the points where it's observed at zero change, they observed a drawdown or a negative change of more than 160 feet.

And errors in the groundwater flow

model, you know, more than 50 feet to 100 feet is really large, and here there were quite a few that were really very large in terms of the magnitude of the error. But, you know, clearly, you know, this would reflect a bias.

Q. Okay. Those -- those are the questions I have about that document.

Let's take a quick two-minute break. Thank you.

A. Sure.

THE VIDEOGRAPHER: We're going off the record. The time is 4:54.

(A recess was taken.)

THE VIDEOGRAPHER: We're back on the record. The time is 5:01 PM.

BY MR. ANWAR:

Q. We're back on the record from a short break.

Dr. Konikow, are you okay to continue?

A. Yes.

Q. Okay. I wanted to ask you a couple questions about -- about each of the two models.

So for Tarawa Terrace, ATSDR used a

simple mixing flow-weighted average model to compute PCE concentrations delivered to the Tarawa Terrace Water Treatment Plant; right?

A. Yes.

Q. And that was from all active supply wells and subsequently to the Tarawa Terrace water supply network.

Does that sound right to you?

A. That sounds right, yes.

Q. Okay. And they did the same thing for Hadnot Point, correct, used a simple mixing model?

A. I believe that's what they did.

Q. And so you'd agree that ATSDR didn't model -- or strike that. Let me ask.

You'd agree that neither the Tarawa Terrace nor the Hadnot Point/Holcomb Boulevard models included calculations for contaminant losses during storage treatment or distribution; right?

A. I believe so.

Q. Meaning you'd agree?

A. Yes.

Q. Okay. So the models don't take

into -- neither Tarawa Terrace model nor the Hadnot Point/Holcomb Boulevard model take into account VOC losses during the water distribution process; correct?

A. My recollection of the expert peer panels is that there were experts there in volatilization and water treatment processes, and they stated, as best I could recollect, that there was not significant volatilization or losses of the VOCs for these particular water treatment plants. And so seemed to me as an expert reviewer of the work that that seemed like a reasonable assumption.

Q. So -- so the models don't take into account VOC losses; correct?

A. The inference was that there are no VOC losses to account for.

Q. So they don't take into account losses that they don't account for; correct?

MR. DEAN: Object to the form.

THE WITNESS: They don't take into account losses that don't exist.

BY MR. ANWAR:

Q. Okay. I think earlier you mentioned

reviewing Sabatini's rebuttal report; correct?

A. Let's say I read it. I, you know, in the sense reviewing it in the sense of having read it, but it was not a technical review of Sabatini's report.

Q. And Dr. Sabatini acknowledges that VOC losses do occur in the water distribution process; right?

A. Very small. You know, he was talking about maybe, as I recall, maybe a 6 percent loss, but it was -- he implied that this was pretty negligible, as I recall.

Q. And you would agree whether it's 6 percent, or some other number, the ATSDR models don't take into account those losses; correct?

A. The groundwater flow and solute transport models that I reviewed did not include the Water Treatment Plant. So what was done to the water distribution model I did not look closely at, but I know that they did not include a volatilization loss in that model.

You know, the data from the Water Treatment Plant, in effect, they were computing what it was, but that didn't go into the model

calibration. It really was a -- I mean, what they ended up doing in the end is increasing the confidence in the groundwater flow and transport models because there was a pretty good match between their estimated concentrations in the Water Treatment Plant and what was actually observed there. So, but that was without considering volatilization.

Q.   Okay. Thank you.

I wanted to talk to you a little bit about the retardation factor. You addressed that?

A.   Yeah.

Q.   You addressed some of Dr. Spiliotopoulos's -- Spiliotopoulos's -- it's been a long day --

A.   Yeah.

Q.   -- opinions --

A.   Yes.

Q.   -- about the retardation factor and the variables in calculating the retardation factor; correct?

A.   Yes.

Q.   Okay. Can you explain to me what a retardation factor is?

A. Okay. The retardation factor reflects that some constituents, like PCE, are somewhat reactive with the solid grains of the aquifer, and they would tend to sorb or ion exchange onto the solid grains.

This means as a net, the net average velocity -- because of sorption and desorption reaction going on, the net velocity of that constituent can be slower than the net average velocity of the water itself.

So you could constituent, you know, it's moving in with the groundwater due to advection. It's spreading a little due to dispersion. But at the same time, some of it gets sorbed and some keeps moving. And then that sorb thing may come off again, desorb and then start moving.

And the net effect of all the sorption, desorption, ion exchange, all the other things going on, reactions or the complex reactions, the net effect is assume that you can on the average represent it with a retardation factor that really represents the ratio of the average velocity of the constituent to the average

velocity of the water. So that if a retardation factor is 3, the constituent moves at one-third the velocity of the water.

Q. Okay. Would it be fair to say the higher -- and you should correct me if I'm misunderstanding this -- but the higher the retardation factor, the longer it takes for the contaminant to travel through the water or the subsurface in the water?

A. I think that's fair.

Q. Okay. And the same sort of relationship exists between bulk density, which is a variable of the retardation factor; correct?

A. I'm not sure I understand the question.

MR. DEAN: Object to form.

BY MR. ANWAR:

Q. Sure.

So bulk density is a variable of the calculation for the retardation factor; correct?

MR. DEAN: Object to form.

THE WITNESS: It's one of the factors that go into estimating the retardation factor if you want to

calculate it based on other factors. I mean, it really comes down to the fact that the retardation factor is a component of the transport equation.

The bulk density, the KD, and the other terms in there are not directly in the governing equation. They're not in the model.

The model kind of externally, you know, it asks for input of KD and bulk density, and then it calculates the retardation factor, and then the solution of the transport equation is based on the retardation factor.

So the, you know, the bottom line is that, you know, the parameter to be calibrated on, the parameter to be estimated really is the retardation factor, not -- not individual estimates of bulk density or KD.

BY MR. ANWAR:

Q. I guess what I was getting at is: If the bulk density increases, doesn't the retardation factor necessarily increase as well,

assuming the other variables remain constant, KD and --

A. Well, sure, but you can't assume that. You know, again, it's -- the parameter that counts is RF. So, you know, for the calibrated model, if you want to say the bulk density is higher, you have to say the KD is lower in a compensating way.

Q. Okay. Dr. Spiliotopoulos pointed out to two errors in ATSDR's Tarawa Terrace model in calculating the retardation factor; correct?

A. He pointed out an error in estimating the bulk density using a wet bulk density instead of a dry. That, and I think they acknowledged. They agreed that that was an error.

Q. And didn't he point out an error in KD as well?

A. I don't recall that but that's...

Q. So if we go to page 10 of your report.

A. Okay.

Q. In the middle of the page under the first paragraph of Opinion 3, middle paragraph you talk about the error that Dr. Spiliotopoulos

caught relating to bulk density, correct, for bulk density?

A. Yes.

Q. Okay. I think maybe I'm misremembering.

But in any event, the middle of the page a little further down it says:

"However, as Dr. Spiliotopoulos himself admits, this significant impact on RF does not actually occur because the calibration process compensates for an overestimate of PB by estimating a value for KD that appears to be too low. Recall that neither of these two parameters are used directly in the transfer model."

Did I read that correctly?

A. Yes.

Q. And so I think what -- if I'm understanding you, you acknowledge that the bulk density was overestimated; correct?

A. And I'm also saying it didn't make any difference.

Q. I understand that.

But you agree that the bulk density was overestimated; correct?

A. Yes, for the Tarawa Terrace.

Q. And you agree that the KD was too low; correct?

A. Well, in the sense that the model was calibrated to RF, and so if row B was too high, then KD had to be too low. This is the whole concept of compensating errors. That's the essence of a model calibration.

Q. But the errors exist is my point; correct?

A. Yes.

Q. And I understand that it's your opinion that they offset each other, so it's not an issue; correct?

A. Well, I think it's -- yeah, it's my opinion. It would also be the opinion of others.

Q. Now, the values used for -- the parameter values used for the retardation factor calculation -- and I think you acknowledge this in your report. I can find the precise place if I need to.

But the values -- the parameter values used to calculate the retardation factor differ between the Tarawa Terrace model and the

Hadnot Point/Holcomb Boulevard model; correct?

A. I believe there was a small difference. Yeah. I think one was 2.9 and the other is 3.3 or something on that order. A small difference but, yeah, a difference.

Q. And that's even though Tarawa Terrace and Hadnot Point were both on Camp Lejeune; correct?

A. Nothing wrong with that. That's a small difference. If you look at the hydraulic conductivity maps, you see much bigger differences over much shorter distances. This is not unexpected in a geologic environment or geologic framework.

Q. And I can pull out the report if you need me to show it to you, but ATSDR states in its report in the Hadnot Point/Holcomb Boulevard study that -- excuse me -- it states in -- yeah, in the Hadnot Point report, Holcomb Boulevard report that sorption in the Hadnot Point/Holcomb Boulevard study area is assumed to be similar to sorption in the study area of -- for Tarawa Terrace.

A. In terms of the process?

Q. Okay.

A. Yeah.
MS. BAUGHMAN: Object to the -- you didn't show him the document, right? You need to show him the document before he answers that.
THE WITNESS: So I think -- I mean, it sounds to me like you're saying they're saying sorption process is sorption process in both areas.
BY MR. ANWAR:
Q. Okay. And wouldn't that dictate that the parameter values for -- wouldn't that suggest that the parameter values between Tarawa Terrace and Hadnot Point/Holcomb -- and Holcomb Boulevard should -- should --
A. Be the same?
Q. -- be similar, the same?
A. Well, they are similar, but they're not the same, and it does not imply that they would be identical.
Q. Okay.
A. Or necessarily close. I mean, again, if you look at the hydraulic conductivity map, for which there are a fair number of aquifer

tests and slug tests and so on, you find much better. You see a much bigger variability between Tarawa Terrace and Hadnot Point in terms of the precise estimates of hydraulic conductivity. Another important parameter.

MR. ANWAR: Okay. I'm going to hand you what I'm marking as Exhibit 19.

(Document marked for identification as Konikow Exhibit 19.)

BY MR. ANWAR:

Q. This is one of the documents that was produced to us last night that was in your possession --

A. Yeah.

Q. -- Dr. Konikow; is that right?

A. That's correct.

Q. Okay. And it is a letter to you from Morris Maslia on behalf of ATSDR providing Mr. Maslia or I guess -- yeah -- ATSDR's responses to your review comments; correct?

A. It's Bob Faye's responses.

Q. Bob Faye's responses. Okay. Thank you.

And I think earlier you had indicated that -- we had a discussion about the issues you raised with respect to limited data for both the models that ATSDR performed and other concerns that were raised, and I think you said that you reviewed the reports recently and those issues had been addressed; correct?

A. The issues had been addressed, and I think some of the details of those are expressed by Bob Faye in this response letter.

Q. Now, in this response letter, Bob Faye, on behalf of ATSDR, doesn't agree with all of the concerns that were expressed; correct?

A. That's correct. That's normal.

Q. And so is it your testimony that this response or this response along with your recent review of the ATSDR reports is what satisfies your -- your belief that the -- your concerns were addressed?

A. Yeah, I think they -- I think they seriously considered every comment and suggestion that I had made and that the expert panel had made, but that doesn't mean they have to accept every one. It's just that I think they did

seriously consider every one of them.
And, again, you know, they're the ones who worked for years on the site. I only looked at it for a few hours.
Q. The major concerns that are listed here, are these the major concerns you raised?
A. This is an outcome of my review of the Chapter F draft report. So yeah, these are issues that I raised, I believe.
Q. And number 1 there is:
"The lumping of two aquifers and one confining unit into the superficial model layer 1."
Correct?
A. Correct.
Q. What was your concern? What was the concern you raised there?
A. Well, I was concerned that -- I mean, it's always -- in developing a model, there's always a conflict between lumping and dividing in a general sense, you know. How much do you want to lump? How much do you want to divide?
My concern was that if there was a

continuous low permeability confining layer lumped in the middle of a single model layer, it might not adequately reflect the vertical velocities through the system.

The responses were, I think, alleviated my concerns, pointing out that the material above the confining layer was generally typically for most of the time unsaturated and really would not be included in the model, and if it had been, would have generated numerical difficulties.

They pointed out that the confining layer is discontinuous, that it's sandy, and that material would -- there was good hydraulic connection through that layer.

And considering everything, I thought, okay, that's a reasonable explanation.

Q. Okay. Is there any part of Robert Faye's response to your concern number 1, major concern number 1 that you disagree with?

A. (Reviews document.)

No. It's an explanation of things that I hadn't fully appreciated at the time I did the review.

Q. Number 2 of your major concerns:
"The use of a finite-difference method to solve the governing transport equation (which causes substantial numerical dispersion, especially if time steps are too large)."
What was your concern there?
A. My concern was that just the finite-difference numerical solution itself can cause calculated concentrations to increase, to spread where it's not related to the physical process of dispersion, and that was my concern. That's a recognized issue sometimes with the finite-difference numerical method for solving the transport equation.
So that was a concern. I think it was a reasonable concern to make sure that they had considered this, evaluated it, and that it wasn't a significant issue.
Q. Did this response satisfy you?
A. Yes. The response, I mean, I think it pointed out that they did carefully consider the Peclet number and the Courant number and that they did testing for grid spacing and time stepping.

Some of this is shown on page 16 where they compared calculations at two wells at three different times for using a one day time step compared with their one month time step that was actually used in the model, and it's an incredibly small difference.

So that is telling me that this is not a problem. It's not an issue. I mean, the differences are in the, you know, 4th significant figure, which is just --

Q. The first --

A. -- not one to be concerned with.

Q. The first sentence of the response to number 2 about the finite -- finite-difference method is:

"First of all the reviewer probably has no idea whether or not using a code based on finite-difference methods caused substantial -- 'substantial' or insubstantial numerical dispersion during solution of the Tarawa Terrace fate and transport model."

Would you agree that you had no idea whether or not using a code based on finite-difference methods caused "substantial" or

insubstantial numerical dispersion during solution of the Tarawa Terrace fate and transport model?

A. For the case of the Tarawa Terrace model, I did not know whether or not it caused substantial numerical dispersion, which is why I was -- and I suspected he didn't know either, and this is why I brought the issue up.

Because in the literature, the issue of numerical dispersion related to finite-difference solutions is in the literature, and that it can under certain circumstances cause substantial numerical dispersion.

By "substantial" I'm not sure exactly what that means, but it can cause numerical dispersion due to the solving of the equation rather than due to the physical processes. This is a recognized issue in solute transport modeling and solving the equation.

As a reviewer, I felt he had to -- because they were using the finite-difference method, I felt he had to address it more carefully than he had.

Q. Okay. Number 3 on the next page, page 4 states:

"The reliability of the estimate of the biodegradation rate constant based on the assumption that concentration declines observed at one location over a period of several years can be explained solely by biodegradation."

What was your concern there?

A. I don't remember all the details of that concern, but I think the way they estimated biodegradation rates. I'm not positive. I think they looked at some condition where the concentration decreased over time, and they used that as a basis for estimating the degradation rate.

And I was raising a concern that how well could they isolate the degradation due to biodegradation versus a reduction in concentration due to advection and dispersion, and, you know, I don't remember in detail what -- how they actually did that calculation. I just don't remember.

Q. And the first line of the response there on number 3 is:

"The authors never claimed that the biodegradation rate computed using field data was reliable or the sole reason for the observed

decline in PCE concentration."

Did I read that correctly?

A. Yes.

Q. So is Robert Faye saying here that the biodegradation rate computed using field data wasn't reliable?

MR. DEAN: Object to form.

THE WITNESS: What I think the implication is, the bottom line is that he's saying that it's a parameter that had to be estimated with the calibration process. It's a parameter, just like the retardation factor.

It's a parameter that you couldn't rely completely on the calculation. You had to use it as a parameter in the calibration method.

It's a parameter that had to be estimated just like the retardation factor, and you adjust the values of these within some reasonable range to yield the best fit for the overall simulation.

And I think what he's saying

here is that he recognizes that this is a parameter to be adjusted during the calibration.

BY MR. ANWAR:

Q. To your knowledge, did ATSDR test higher biodegradation rates for TT, for Tarawa Terrace?

A. I believe they did.

Q. Did you evaluate the range of biodegradation rates that ATSDR considered?

A. I -- I'm sure I looked at it, but I didn't do a detailed evaluation of it. I'm pretty sure I did not, but I think certainly at the time I did the review, I was aware of what they did.

Q. Do you recall the biodegradation rate that they ended up using for Tarawa Terrace?

A. Yeah. Yeah. I mean, here they're talking about .0005 in that range, and so I assume they went up and down from 0005 to a higher value and a lower value. I don't recall exactly what the range was.

Q. Number 4 on page 4 states:

"The exclusion of concentration data collected in monitoring wells from the calibration

basis."

Why was it a major concern to you to exclude concentration data collected in monitoring wells for calibration?

A. I'm not sure if it was a major concern compared with some other things. It was a concern, and I didn't understand why if they had concentration data from a monitoring well or from a point, why they would not use that in the calibration.

I'm -- I'm, you know, he gave an answer, but I'm still not sure why. If I was doing it, I probably would have used those values, with the recognition that it's a sample from a point rather than a pumping well that brings in lots of water.

So I think that was kind of his basis for not using it is that it was sampling an extremely small volume of the aquifer.

I would have, you know, I, you know, if I was doing it, I would say, well, it's still a point within the volume and I would have -- I would have looked at it and, you know, I might -- unless I saw some reason not to, I would have used

it in the calibration.

But he had a reason for not and, you know, we may disagree on that.

Q. Okay. So that may be at least one area where you disagree in terms of these comments?

A. Well, to some extent. You know, it's certainly not a fatal flaw in the calibration. It's a -- it's his way of looking at it and I, you know, he had experience in the area. He worked it for years.

I only, you know, spent two days reviewing it. So, you know, that's -- I didn't have the hands-on experience he did, but -- but from what I, you know, I probably would have used the monitoring well data as part of the calibration.

Q. Okay. The number 5 there on page 5 identifies as a concern that you had:

"The use of a much larger mass loading rate than apparently was indicated by the field data in order to improve model calibration."

Tell me about that concern.

A. I don't remember the details of why

I said that. I can't remember.

Except that there must -- there probably was some indication or initial estimate of what the mass loading rate was, and it was adjusted in the model calibration to achieve the best fit, and that calibration indicated a much higher mass loading rate.

And, you know, it's -- it's an issue, again, I don't recall the details of.

Q. So Robert Faye in his response starts by saying:

"First of all please note that field data did not indicate a mass loading rate. The computations of PCE mass in the saturated and unsaturated zones described in the report were the result of a highly interpretative, somewhat subjective calculation using field data."

Do you see that there?

A. Yes.

Q. What is -- what was your reaction to that response to the concern you had expressed?

A. You know, I don't remember my reaction at the time but, you know, you're looking at it now. He's explaining what he did, maybe a

little more clearly than was in the report.

You know, he's saying that there's some subjectivity and approximations that went into that calculation, which itself is not surprising considering the nature of the sources.

Q. Did you disagree at all with the mass loading rate ATSDR chose to use?

A. Not per se, no. No.

Q. Do you disagree with the start date for contamination that ATSDR chose to use for Tarawa Terrace?

A. No, it seemed reasonable.

Q. Between the Tarawa Terrace model and the Hadnot Point and Holcomb Boulevard model, do you view one model as better or more accurate than the other?

MR. DEAN: Object to form.

THE WITNESS: Both models, I think, are reasonable, using well accepted state-of-the-art methods. I think both models are quite acceptable. I think their predictions are reasonable, with the recognition of uncertainty.

The Tarawa Terrace model

clearly had a better defined source term and that, you know, probably yields a little more confidence in that model. A little more confidence in the results.

But the numerical solutions I think are good numerical solutions in both cases given the assumptions about the stresses on the system and the parameters.

I mean, they're basically the same model in the sense that they're both using MODFLOW and MT3D, which are both good models.

BY MR. ANWAR:

Q. The Hadnot Point/Holcomb Boulevard site was more complex to model than Tarawa Terrace; right?

A. In the sense of source terms and mass loading, yes. Other than that, I think they're equivalent.

Q. There were more sources at Hadnot Point; correct?

A. Yes. Yes.

Q. There were -- were there more wells

to examine in Hadnot Point/Holcomb Boulevard?

A. Probably a few more. I think -- yeah, I think there were more. I don't recall the numbers, though, but...

Q. Was Hadnot Point/Holcomb Boulevard a generally larger area to model?

A. It was somewhat larger, yeah, and also they -- for the transport, they broke it down into two separate MT3D models. One focusing on the landfill area and another focusing on the industrial area. So there wasn't one MT3D model for the Hadnot Point/Holcomb Boulevard. There's one flow model.

Q. The Holcomb Boulevard/Hadnot Point model also included a water distribution model to simulate connections between Hadnot Point and Holcomb Boulevard; right?

A. I believe so.

Q. And that was an additional complexity introduced into the Hadnot Point/Holcomb Boulevard modeling; correct?

A. I guess you could say that. I don't think that was a major complexity, but yeah, it was an additional factor.

Q. Could you turn to page 10 of this document.
A. Okay.
Q. In the middle of the page, so page 46 to 49.
A. 59?
Q. 59. Excuse me. Thank you.
It looks like Robert Faye agrees with a suggestion you made, and it says "A sentence has been added to the report."
Do you see that?
A. Yes.
Q. And then underneath that, he discusses biodegradation rate again and he says:
"Disagree. This criticism was previously addressed under Major Concerns, item #3," which we just discussed. "The reviewer's suggestion to simulate PCE concentrations using a degradation rate of zero and adjust the field data by simulated changes is not accepted. Adjustments to field data using such simulated changes would not add any additional certainty -- any additional -- would -- excuse me -- adjustments to field data using such simulated changes would add

additional uncertainty to an already uncertain process."

Do you agree with what he's saying there?

A. I think it's a reasonable perspective and so, yeah, I certainly would accept that comment.

Q. You had suggested, according to this document, "to simulate PCE concentrations using a degradation rate of zero and adjust the field data by simulated change -- and adjust the field data by simulated changes."

What did you mean by that?

A. First of all, I don't remember precisely what I suggested. I don't have that original comment in front of me.

But just from what it says here, I'm assuming I had suggested whatever biodegradation rate he used, I said rerun it with zero and assess, you know, see what difference is. What -- what -- assess at least qualitatively what the impact of that biodegradation is.

But I don't recall it precisely or at all exactly what I said there, but it was a

suggestion. He didn't. He disagreed, and I think that's fine.

Q. Okay. On -- if you skip down a couple of the page 59 comment.

A. Yeah.

Q. It says "Mass loading" and Robert Faye says:

"Disagree. See comments under Major Concerns, item #5. The reviewer seems to assign a high degree of accuracy and credibility to the PCE mass computation that is unwarranted. As explained previously, the computation of PCE mass was a highly interpretative and somewhat subjective -- highly interpretative and somewhat subjective process frequently based on questionable data."

Did I read that portion correctly?

A. You read it correctly.

Q. Do you have any understanding of what means when he says "the computation of PCE mass was a highly interpretative and somewhat subjective process frequently based on questionable data"?

MR. DEAN: Object to the form.

THE WITNESS: You know, I'm -- right now I'm not sure what he meant. I don't recall at the time if I understood what he meant. I'm just -- I'm just not sure.

Except that he's -- he's saying that the computation of PCE mass, there's a lot of uncertainty there seems to be what he's saying, and I certainly don't disagree with that.

I don't -- I don't recall assigning a high degree of accuracy to it, but he seems to imply that I did or at least he inferred that I did. I don't think I would have, but I don't know.

BY MR. ANWAR:

Q. That's what the document states; right?

A. Yeah.

Q. He goes on to say in the rest of that:

"Field data applied to the PCE mass computation were limited both spatially and vertically. The computation was accomplished

regardless of data limitations to provide an estimate of a minimum mass loading rate to use to begin model calibration."

Is that right?

A. Okay. Tell me again which paragraph you're reading. The first paragraph on page 59 or the second one under that? Sorry. I lost track.

Q. No, it's okay. It's okay. I think you -- you addressed what I was asking you.

MR. ANWAR: Let's take a short break. I think I'm close to wrapped up. I just want to check my notes.

THE VIDEOGRAPHER: We're going off the record. The time is 5:43 PM.

(A recess was taken.)

THE VIDEOGRAPHER: We're back on the record. The time is 5:51 PM.

BY MR. ANWAR:

Q. Okay. A few more questions for you, Dr. Konikow.

A. Okay.

Q. I appreciate you're willingness to speak with us. I know it's been a long day.

I wanted to ask you.

In terms of parameter estimation or determining parameters as inputs in the model, generally speaking, is it better -- is a parameter that reflects the real world better than one that doesn't?

A. That seems like a reasonable statement.

MR. ANWAR: Okay. Okay. I'm handing you what I'm marking as Exhibit 20.

(Document marked for identification as Konikow Exhibit 20.)

BY MR. ANWAR:

Q. And I will just represent to you that this is ATSDR's response to a critique that the Navy offered about the Tarawa Terrace modeling.

Have you seen this before?

A. Not that I recall.

Q. Okay. Did you review the Navy's critique of the Tarawa Terrace model in forming your -- the opinions in your rebuttal report?

A. No, I don't remember seeing this.

Q. Okay. If you could turn to

page -- I'm going to have to identify it by the Bates ranges. It's the page ending 33271.

A. Say that again.

Q. So at the bottom, there's a little Bates stamp that says "CLJA_WATERMODELING."

A. Yes.

Q. And then there's a number. It's the one at the end that says 33271.

A. 33271?

Q. Correct.

It's in the middle of the page, there is a comment from the Navy labeled 7.1.

Do you see that?

A. Yeah.

Q. Okay. And so I just wanted for context to provide you the -- or show you the comment that ATSDR was responding to.

The Navy stated:

"However, all comparisons did not fall within the calibration range. At the Water Treatment Plant, 12% of the simulated PCE concentrations failed the calibration standard ... at the water supply wells, a majority (53%) of the simulated concentrations fell outside of the

outside the calibration standard."

Did I read that correctly?

A. You read it correctly.

Q. Is that consistent with your understanding of the calibration for the Tarawa Terrace model?

MR. DEAN: Objection to the form of the question.

THE WITNESS: I'm not sure, but I've seen that 53 percent number, I think, in Alex Spiliotopoulos' in his report, and I disagree that that was a fair assessment of the accuracy.

BY MR. ANWAR:

Q. Okay. If you turn the page, ATSDR responds -- well, ATSDR starts responding on the prior page, but their response goes on to the next page.

So on the page ending 33272, I just wanted to ask you about a portion of their response.

A. Okay.

Q. The very last paragraph there states:

"To address the issue of the intended use of the water-modeling results by the current ATSDR epidemiological study, the Department of Navy should be advised that a successful epidemiological study places little emphasis on the actual (absolute) estimate of concentration and, rather, emphasizes the relative level of exposure. That is, exposed individuals are, in effect, ranked by exposure level and maintain their rank order of exposure level regardless of how far off the estimated concentration is to the true -- 'true' (measured) PCE concentration. This rank order of exposure level is preserved regardless of whether the mean or the upper or lower 95% of simulated levels are used to estimate the monthly average contaminant levels. It is not the goal of the ATSDR health study to infer which health effects occur at specific PCE concentrations -- this task is for risk assessment utilizing approaches such as meta-analysis to summarize evidence from several epidemiological studies because a single epidemiological study is generally insufficient to make this determination."

And then it goes on:
"The goal of the ATSDR epidemiological analysis is to evaluate exposure-response relationships to determine whether the risk for a specific disease increases as the level of the contaminant (either as a categorical variable or continuous variable) increases."
Did I read that correctly?
A. I think you read it correctly, yeah.
Q. What do you understand ATSDR to be saying in this response?
MR. DEAN: Object to the form of the question.
You want him to comment on what ATSDR is saying, right?
MR. ANWAR: Isn't that what he's doing anyway?
MR. DEAN: No. Object to form.
MR. ANWAR: That's his role as an expert.
THE WITNESS: I think what they're saying is that the exposure

levels are considered in terms of a ranking based on how -- where it is in the scale and that it's not based on the actual concentration value.

So it's like a high, low, medium or, you know, some -- something on that scale rather than 95.3 to 89.9 or anything like that.

So but, again, I'm, you know, I'm certainly not an expert in epidemiological studies, so I'm not sure what all the implications here are.

BY MR. ANWAR:

Q. It appears to me he's saying, for the purpose of a successful epidemiological study, at least the one ATSDR was conducting, and I'm quoting, it says:

"Places little emphasis on the actual (absolute) estimate of concentration" and then it goes on to say "regardless of how far off the estimated concentration is to the 'true' (measured) PCE concentration."

Based on that, it appears to me he's saying that for this model for the purpose that it

was intended for in terms of providing information for epidemiological studies, it doesn't matter what the absolute concentrations levels are produced by the model and it doesn't matter if they're inaccurate.

Do you agree with that?

MR. DEAN: Object to the form.

THE WITNESS: Well, it depends what you mean by "inaccurate" because if you, you know, you still want it accurate in the sense of what's high is high and what's low is low, what's in the middle is in the middle.

You know, the actual concentration level we already know has uncertain -- that's computed we know has uncertainty associated with it.

So there's, you know, it's naturally going to be imprecise and, you know, you can't say it's going to be 99.5 micrograms per liter because it might be higher or lower because of all the uncertainty in the model.

But you certainly want

consistency in the model. You want the model to, you know, have a good mass balance. You want, you know, the numerical solution should be accurate for the conditions in terms of solving the equation.

I think all of those conditions are met.

What exactly they mean by a rank order I'm not precisely sure, but I would imply that some -- this is somehow related to exposure levels, but I don't completely understand that.

BY MR. ANWAR:

Q. Does this response change or inform anything that you've stated today about the -- the accuracy of the model predictions, the simulated contaminant concentrations produced by the ATSDR models?

A. No. No. I mean, I'm not evaluating the model from a perspective of the health exposure studies.

I'm evaluating it in terms of the solution to the equation for the initial

conditions, the boundary conditions, the estimated parameters, and everything related to that.

So, you know, the concentrations in the Water Treatment Plant, to the best of my knowledge, were not used for the calibration but served as a way to increase confidence in the model.

These were computed by the mixing model that you mentioned a few minutes ago, which was really subsequent to the MT3D modeling.

So it's kind of like a next -- I wouldn't call it independent, but it's a -- it's a kind of standalone process that estimated the concentrations in the Water Treatment Plant based on what the computed results of the model.

And these were not part of the calibration, to my best recollection, but it certainly served to increase confidence in the model because those, you know, where they did have observed data, it generally looked reasonably good in terms of matching the -- you know, what this mixing model did to estimate the concentrations in many cases agreed closely with what was observed.

Q. Okay. As a -- those are the

questions I had about this document.

As a member of the National Academy of Engineering and as someone that has served on National Research Council committees in the past, were you aware that the National Research Council also issued a report on ATSDR's water modeling efforts?

A. I believe it was 2009?

Q. Correct.

A. Yes, I was aware of that.

Q. The report itself addressed sort of epidemiology -- epidemiological and broader issues, but there was a portion focused on --

A. Yeah.

Q. -- exposure assessment and the water modeling.

Were you aware of that?

A. I -- I read the charge of the committee, and the charge of the committee really focused on epidemiological studies and health effects. The charge to the committee did not -- actually did not mention the groundwater modeling at all, but obviously the groundwater modeling was what led to the estimates. So that was a

legitimate domain for their discussions.

But, you know, the committee, I looked at the committee membership. You know, I think there were 10 or 11 members. There was only one who had any expertise in groundwater. The rest were medical and health effects and epidemiologist experts because that was the main charge to the committee.

Q. Who was the one expert that was the groundwater modeler?

A. Professor Clement.

Q. Okay. And what are your opinions about -- so let me back up.

Are you aware of what the NRC said about ATSDR's water modeling efforts?

A. I looked at that report. I don't recall their exact comments.

Q. Do you have any opinion about the National Research Council's comments on the ATSDR water modeling efforts?

A. I think I had a few comments because Spiliotopoulos made some comments about it. So I think I had some comments in my rebuttal report about it.

Q. Do you remember what those comments are?

(Mr. Dean no longer present).

A. I see that it's not a huge report. I can probably find it pretty quickly.

One of my comments was that of all the members of the panel, there was only one who was an expert in groundwater, and that's a really minority on an NRC panel.

What I recall about Clement publishing an article in "Groundwater" about model complexity, and he was using the case study of ATSDR, I presume based on his experience on the NRC panel, and he was critical of the ATSDR model and then that was in the published article.

Then Morris Maslia published a very detailed response that was published in the journal to his comments, and I thought he did an excellent job countering all of the criticisms.

And then Dr. Clement had a reply to the responses, in which the first thing he said was that "My analysis should not be considered a review of the ATSDR modeling," which to me countered everything he had said in the first

article about what he did say was that the purpose of his article was to generate discussion about model complexity in general and he did not intend to, you know, as a criticism.

What he implied to me is that he did not do a technical in-depth, detailed review of the ATSDR models, which was very disappointing.

His response, the first words pretty much wanted to set aside any criticism and concern about the ATSDR models. He backed off of with what, I think, were his criticisms. He couldn't defend them.

Q. Do you -- do you know Professor -- I think is it -- Prabhakar Clement?

A. I have met him occasionally. I have had a few e-mail discussions with him. When I was an editor of "Groundwater Journal," he had submitted a discussion article and so we discussed that.

Q. Have you spoken with him at all about Camp Lejeune?

A. No, not that I recall. No, I don't think so.

Q. Do you have any opinion of Professor

Clement?

A. Not really. I don't know his work that well. He hasn't published as much as other people in the groundwater field, but I know he, you know, he certainly is trained as a groundwater specialist.

Q. And in order to -- to have served on the role on for the National Research Committee, he had to have been elected as a member of NRC by his peers; right? Or no?

A. No, absolutely not.

Q. Okay.

A. You -- most people who serve on NRC committees are not members of the Academy.

Q. Okay. Do you know if he is?

A. And all those committees that are, I was not a member of the Academy when I served on those committees, and most of the people on the committees were not members. So it's kind of two different things.

Q. Okay. Understood. That makes sense.

Do you by chance, do you know if he's been elected to --

A. I am 99.9 percent sure that he was not.

MR. ANWAR: Okay. I'm going to hand you one last exhibit.

(Document marked for identification as Konikow Exhibit 21.)

BY MR. ANWAR:

Q. Exhibit 21, and I'll just represent to you this is the chapter about "Exposure to Contaminants in Water Supplies at Camp Lejeune" from the NRC report. The larger report from -- from -- about Camp Lejeune.

Have you seen this before?

A. This is the 2009 report?

Q. Correct.

A. Well, I looked at the 2009 report, but I, you know, I don't specifically recall seeing this.

Q. Okay. I just wanted to ask you a few questions about --

A. Sure.

Q. -- some of the conclusions they made at the end.

If you turn to the second to last

page of the document. It's ending in 516.

A. Okay.

Q. The second paragraph states:

"ATSDR applied best practices and cutting-edge modeling approaches to predict the complex groundwater-contamination scenario at Tarawa Terrace."

Would you agree with that statement?

A. Yes, sounds like a compliment.

Q. "The ultimate outcome of the modeling was average monthly predictions of the concentrations of contaminants in the water supply to which people could have been exposed. Although ATSDR recognized and tried to account for the limitations and uncertainties associated with developing its models, it is extremely difficult to obtain quantitative estimates of historical levels of PCE -- excuse me -- exposure to PCE and its degradation products reliably on a monthly basis."

Do you agree with those statements?

MS. BAUGHMAN: Objection. Form.

THE WITNESS: Well, I mean, I

thought it was a challenging exercise and difficult also, but they did it.

BY MR. ANWAR:

Q. It goes on to state:

"Reporting such model predictions without clear error bounds gives the impression that the exposure of former residents and workers at Tarawa Terrace during specific periods within a given year can be accurately defined."

Would you agree with that statement?

A. Well, I don't -- I disagree that the predictions were presented without clear error bounds. I thought pervasive in all the ATSDR reports was -- were discussions of error bounds, uncertainty, you know, how the results could vary under a different range of assumptions.

So I thought they did a nice job presenting clear error bounds.

Q. Can I ask you.

I guess for someone who may have been at Camp Lejeune, a former service member or a resident there, who was interested in looking at ATSDR's simulated concentrations, looked at the reports or turned to the reports.

Based on your experience, would a layperson be able to understand the concepts and the uncertainty analysis presented in ATSDR's report?

MS. BAUGHMAN: Object to the form.

THE WITNESS: I'm not sure what a layperson would understand or get from it. I think it's just highly variable with a person depending on how much background they have in statistics and math and geology, if they have any background at all or how much. You know, I think that understandability in the public would be highly variable.

BY MR. ANWAR:

Q. "It is the committee's judgment" -- so this paragraph goes on.

"It is the committee's judgment that ATSDR's model is suitable only for estimating long-term exposure quality. From that perspective --"

MS. BAUGHMAN: Qualitatively.

MR. ANWAR: "Qualitatively."

Thank you. I'm sorry.

BY MR. ANWAR:

Q. I'll read that again.

"It is the committee's judgment that ATSDR's model is suitable only for estimating long-term exposure qualitatively. From that perspective, a single exposure category of 'exposed' appears to be applicable for persons residing or working at Tarawa Terrace at any time during 1957 to 1985."

Do you agree with that statement?

MS. BAUGHMAN: Object to the form.

THE WITNESS: I -- I -- I don't. No, I don't think I do because, you know, you know, there they seem to be relating it to either exposed or not exposed and ignoring any of the scale of variability in the concentrations.

So I think the ATSDR models were better than that.

BY MR. ANWAR:

Q. Okay. That last paragraph on that portion says:

"Efforts at historical reconstruction of exposures at Hadnot Point will be even more problematic. The contamination scenario at Hadnot Point is so complex that the committee judges that only crude estimates of contaminant concentrations in the water supply can be obtained."

Do you agree with that statement?

MS. BAUGHMAN: Objection. Form.

THE WITNESS: Not completely and, again, I point out that before I served on the Hadnot Point/Holcomb Boulevard expert peer review panel, I was quite skeptical myself and, in that sense, at that time maybe I would have agreed with this statement.

But I learned a lot. They explained a lot. I saw the final reports. I think they did a good job modeling, a reasonable. Modeling results are reasonably reliable.

I think there's certainly more uncertainty there than probably in the

Tarawa Terrace model, but I think -- I think they were successful in putting together a reasonable model.

They explained all their assumptions and approximations, and there clearly are assumptions and approximations underlying the models, underlying that. So that, you know, it's there, but it's a good model.

BY MR. ANWAR:

Q. When we're talking about successful in terms of putting together a good model, ATSDR, do you think they were successful in putting together a good model for providing information to an epidemiology -- EPI study, epidemiological study?

MS. BAUGHMAN: Object to the form.

THE WITNESS: In recognition that the epidemiological study did not make an assessment based on the actual concentration level in the calibrated model, but rather a ranked form that kind of removes some of that.

But, you know, without any understanding of their epidemiological studies, it seemed like the output from the models provided something that would be useful for them.

BY MR. ANWAR:

Q. Okay. And when you say the model was successful, ATSDR was successful, and it was a good model, are you saying that it was successful and a good model for the purpose of estimating exposure in individuals?

A. I don't know.

MS. BAUGHMAN: Objection. Form.

THE WITNESS: I don't know how it was used for exposure. I didn't look at the exposure studies or the epidemiological studies. So I really can't --

BY MR. ANWAR:

Q. Okay.

A. -- say.

Q. Last question.

Do you -- what -- what is your

opinion of Robert Faye?
A. Of Robert Faye?
Q. Yeah.
A. He seems to be a competent hydrogeologist, primarily in the, you know, in the practical application end of hydrogeology. He's not an academic in the sense of producing papers on research and theory, but I think he has a lot of experience and knowledge in terms of field applications, studies, the reality of geology and the hydrogeologic framework and the use of models.
Q. When is the last time you spoke to him?
A. Way more than 10 years ago.
Q. Okay. I really appreciate your time today and your patience with my questions. I think that's all I have. I'll pass the witness.
A. Thank you.

EXAMINATION

BY MS. BAUGHMAN:
Q. Dr. Konikow, I just have a few questions for you.
A. Yeah.
Q. You were just asking -- asked

questions about what you meant by successful in terms of the ATSDR models.

Do you have an opinion about whether ATSDR was successful in estimating the mean monthly concentrations of contaminants at Tarawa Terrace?

A. At Tarawa Terrace? I think those were reasonably reliable. Again, always reasonable in light of the uncertainty and the error bounds about it. I think the calibrated models were provided -- they were successful in providing estimates and in assessing the uncertainty in those estimates. So I think that, yeah, I would say they were successful.

Q. And do you have the same opinion for Hadnot Point?

A. I do. Again, there it was a more complicated problem and, you know, many people probably would have thrown their hands up and said, we can't do it. But they did it and, you know, I think the important thing is they carefully documented all of their assumptions, how they got at mass loading, pumping rates, pumping schedules, and assessing uncertainty in those as

well as uncertainty -- assessing uncertainty in many of the physical parameters.

Q. Okay. If an end user wants to use the mean monthly concentrations for an epidemiology study versus an individual exposure, right, how if at all would that change -- (cell phone) -- let me -- let me start over.

If an end user wanted to use the mean monthly concentrations to estimate an individual's exposure as opposed to for purposes of an epidemiology study, how if at all would that change how the model would be developed?

And I'm asking you in your expertise as a hydrogeologist.

MR. ANWAR: Object to form.

BY MS. BAUGHMAN:

Q. In other words, if you're using the mean monthly concentrations for individual exposure as opposed to an epidemiology study, does that change how you develop the model?

A. It should not. You know, again, I think I said it earlier, maybe this morning.

But what the end user does or intends or wants really should have minimal impact

on the development of the model, other than to make, you know, if the end user, who's paying for the model study, says, I need an estimate at this point in space, then, okay, you make sure that you calculate it at that point in space.

But the model itself should not be affected by the end use of it. In other words, the model should do the best job they can. Get the most accurate result they could. Calibrate the model, document the model and its accuracy, and then use the results whatever you want to use it.

Q. And just to be clear, if -- if a medical doctor wanted to use the mean monthly concentrations to calculate an individual's exposure as opposed to for some other purpose, like an epidemiology study, would that change how the hydrogeologist gets to what the mean monthly concentrations are?

MR. ANWAR: Object to form.

BY MS. BAUGHMAN:

Q. From a modeling perspective?

A. Should not, no.

Q. Okay.

A. I don't think it would.

Q. Okay. Is there a difference between the words "valid" and "validated" or "validation" in terms of hydrogeology and water modeling?

A. These are terms that not everyone agrees on their meaning or intent, but it's very common that just using the word "valid" by itself is generally okay. You're saying that it's appropriate for what it's being used for.

The word "validated" it has, I think, more of an implication that you've got the right model and you prove that you got the right model, and that's generally not accepted in science that, you know, for all the reasons in my published paper.

Q. So if when you use the phrase "scientifically valid," is that another way of saying that ATSDR adhered to generally accepted methodologies?

A. That's -- yeah. You're using standard practices, common practices, well accepted, well-documented methods and approaches that are well accepted, in other words, yeah.

MS. BAUGHMAN: Okay. Thank

you. I have no other questions for you.

MR. ANWAR: I have nothing either.

Thank you for your time today.

MS. BAUGHMAN: You're finished.

THE WITNESS: Okay. Thank you all.

THE VIDEOGRAPHER: Please stand by.

We're off the record at 6:23 PM. This concludes today's testimony given by Dr. Konikow.

(Signature not waived, the deposition concluded at 6:23 p.m.)

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DECLARATION UNDER PENALTY OF PERJURY

I declare under penalty of perjury that I have read the entire transcript of my Deposition taken in the captioned matter or the same has been read to me, and the same is true and accurate, save and except for changes and/or corrections, if any, as indicated by me on the DEPOSITION ERRATA SHEET hereof, with the understanding that I offer these changes as if still under oath.

Signed on the ______ day of ____________, 2024.

____

LEONARD KONIKOW, PHD

CERTIFICATE OF REPORTER

COMMONWEALTH OF VIRGINIA)

I, Denise Dobner Vickery, a Registered Court Reporter and Notary Public of the Commonwealth of Virginia, do hereby certify that the witness was first duly sworn by me.

I do further certify that the foregoing is a verbatim transcript of the testimony as taken stenographically by me at the time, place and on the date herein set forth, to the best of my ability.

I do further certify that I am neither a relative nor employee nor counsel of any of the parties to this action, and that I am neither a relative nor employee of such counsel, and that I am not financially interested in the outcome of this action.

Denise D. Vickery

DENISE DOBNER VICKERY, CRR,RMR
Notary Public in and for the
Commonwealth of Virginia

My Commission expires: March 31, 2026
Notary Registration No. 126014